The Blast Furnace and Steel Plant

The Blast Furnace and Steel Plant

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The Blast Furnace and Steel Plant

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The Electric Furnace and Electric Steel

Data Collected by the Electric Furnace Association Relative to the Quality of Electric Furnace Products — Statistics on Electric Steel Production.

A COMMITTEE of the Electric Furnace Association is engaged in collecting substantiated information relative to the quality of electric furnace products. Quite a little such information has been obtained from papers and articles on electric steel, and some figures have been given by manufacturers of these steels.

The figures and statements herein presented have been largely used just as they were procured from the various sources. Incomplete as they may be, it was the thought that the gathering of them together in one article would be of interest to steel men and would also be of value in showing how consistently electric steels can measure up to severe specifications. No attempt has been made to edit these figures or to interpret them to any extent, as the committee felt that this could be done much better after more data had been obtained.

In reporting that the results obtained on physical tests of electric steel are universally superior to those obtained from converter steel one manufacturer gives the following figures for electric steel castings:

Analysis.

No.	C	Si	S	P	Mn
1	0.19	0.23	0.025	0.044	0.74
2	0.23	0.20	0.021	0.040	0.64
3	0.19	0.27	0.043	0.036	0.52
4	0.24	0.33	0.050	0.056	0.70

Physical.

No.	Tensile strength lbs. sq. in.	Elastic limit lbs. sq. in.	Reduction in area	Elongation in 2 in.
1	66,750	42,500	51.7%	35.0%
2	76,000	45,000	45.8%	30.0%
3	62,400	36,500	50.0%	32.0%
4	69,000	37,800	44.0%	28.0%

Samples 1 and 2 are basic, while 3 and 4 are acid. This manufacturer also makes converter steel, and with such steel an average reduction of 25 per cent was difficult to maintain and elongation usually ran about 20 per cent. Of particular interest is his statement that such results as the above were consistently obtained in every heat of electric steel. These figures were taken at random.

The following figures are submitted by another well known firm as typical of their every day electric steel casting output. Of particular interest is the low phosphorus and sulphur, and also high ratio of elastic limit to ultimate strength, this being over 50 per cent of the tensile strength:

Analysis.

No.	Car.	Sul.	Phos.	Mang.	Sil.
1	0.80	0.027	0.020	0.62	0.40
2	0.40	0.020	0.011	0.52	0.50
3	0.23	0.024	0.018	0.55	0.35
4	0.18	0.022	0.016	0.70	0.40

Physical.

No.	Ultimate strength	Elastic limit	Elongation	Reduction of area
1	113,250	62,250	15.0	20.2
2	97,300	49,230	20.5	29.4
3	70,000	37,500	33.5	52.0
4	62,500	39,000	34.2	55.5

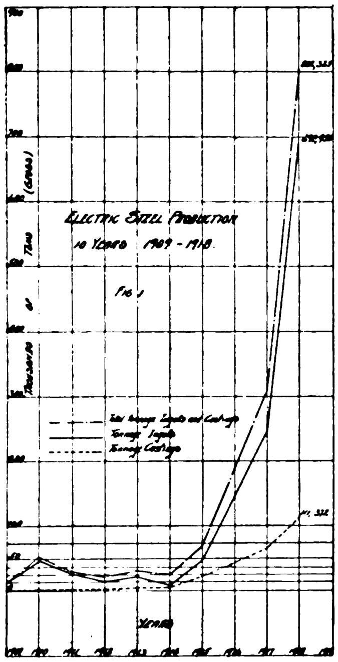
Some very significant comparisons of open hearth and electric steel castings were submitted. Among them were physical tests on steels averaging in composition C-0.25, Si-0.20, Mn.-0.55, S-.010, P-.010.

	Open Hearth	Electric
Elastic limit, lbs. per sq. in.	35,000	45,000
Ultimate strength lbs. per sq. in.	70,000	80,000
Elongation	15%	30%
Reduction of area	50%	45%

The firm submitting these figures was engaged in manufacturing steel for marine work. They say "electric steels of this class give 90 and 100 foot pounds Izod impact test against 12 to 15 pounds for open hearth steels." This manufacturer has consistently obtained an exceedingly tough steel very resistive to vibrating and alternating shocks and stresses, such as are experienced by a propeller shaft for example. He believes that microscopic examination would show properly made electric steel to be almost entirely free of slag inclusions or such flaws which so often start the line of fracture in open hearth or converter steels.

Another manufacturer gives the following comparative results from steels of similar composition for forged armature shafts:

Properties	Open Hearth	Electric
Ultimate strength, lbs. per sq. in.	91,200	107,700
Elastic limit, lbs. per sq. in.	46,000	69,950
Elongation	22.2%	23 5%
Reduction of area	44.8%	50.0%
Elastic—torsion, lbs. sq. in.	16,750	33,700
Shearing strength, lbs. sq. in.	62,400	76,000



Results of tests made by R. W. Hunt & Co. on electric railway axle steel of A. E. R. A. specifications illustrate the physical properties of heat-treated electric furnace steel; heated to 1,450-1,460 degrees F. held one hour, then quenched in 65 degrees oil, and then drawn at 1,185-1,200 degrees F. for one hour, and cooled slowly in furnace. Open hearth steel had been similarly heat treated after forging.

	Basic Open Hearth	Basic Electric
E. Lim. lbs. per sq. in.	41,060 lbs.	64,850
Tensile strength lbs. per sq. in.	89,100 lbs.	105,140
Elongation in 2 in.	21.5%	22 0%
Reduction of area	31.74%	52.37%
Elastic torsion	16,750 lbs.	33,700

Excellent results were obtained by electric steel makers in munition work. Typical among these are some figures on forgings of low nickel chrome gun steel for the navy. These three heats after forging were quenched at 875 degrees C. and drawn back at 650 degrees C.

Analysis.

No.	C. Per cent	Mn. Per cent	Si Per cent	P. Per cent	S. Per cent	Cr. Per cent	Ni. Per cent
1	.35	56	.11	.029	.023	.34	2.25
2	.35	.57	.19	.010	.025	.40	3.40
3	.39	.54	.11	.023	.026	.45	2.91

Physical.

	Ultimate	Elastic	Elongation % in 2"	Reduction Area—%
1	102,000	65,000	21%	52.5%
2	105,850	74 000	22%	54 1%
3	102,125	60,000	22.5%	51.8%

The foregoing figures from everyday shop practice and other data collected by the data committee of the association all indicate that in making steel of any given chemical composition that produced in the electric furnace will give better figures on physical tests and will be a tougher, better steel.

Electric Steel Production.

That this quality is becoming recognized and that the manufacture of electric steel is now a well established industry is shown by statistics recently published by the American Iron and Steel Institute. The increase in tonnage of electric steel produced and the quantity going into ingots and castings are shown in the curve. (Fig. 1). This diagram also indicates that in 1914 electric steel passed the experimental stage and became a practical modern method of making high grade steel.

In this connection the total steel production of the United States during the past 10 years will be of interest.

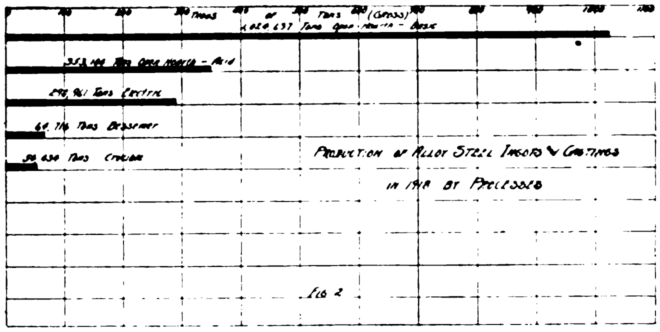
It will be noticed that while the total annual steel output of the country has about doubled in the last five years, the tonnage of electric steel has been increased over 20 fold. In tonnage the electric furnace leads the crucible by a wide margin, the latter having just about stood still since the electric furnace appeared. The electric process has passed the crucible and Bessemer processes for the production of alloy steels and is almost equal to the open hearth acid process. A little more than 16 per cent of the 1918 alloy steel production came from the electric process; 36 per cent of the 1918 electric steel output went into alloy steels.

A diagram shows the position of the electric furnace in the alloy steel field. (See Fig. 2.)

The growth in the demand for alloy steel ingots and castings can be seen by comparing the output of these steels for a few years back, according to figures of the American Iron and Steel Institute.

Year	Ingots	Castings	Total
1909	158,978	23,002	181,980
1912	689,392	103,109	792,591
1915	923 251	97,896	1 021 147
1918	1,721,367	66,485	1,787,852

In total tonnage production of ordinary steel castings the electric furnace has already passed the crucible and in 1918 was approaching the converter casting output. In making this comparison it should be borne in mind that the same class of castings is not made in these two processes. In 1918 production of electric steel castings was nearly five times that of 1915.



That electric steel has established its position the world over is shown by the following table, which gives the number of such furnaces in each country.

The total tonnage capacity of the electric steel furnaces in 1919, of the United States, was about 1,350 short tons. On the basis of three heats per day, operating 300 days per annum, these furnaces are

Electric Steel and Total Steel Production in United States (Gross Tons)

	Steel Ingots and Castings					Alloy Steels			
Year	Open Hearth	Bessemer	Crucible	Electric	Misc.	Open Hearth Bessemer Crucible	Electric	Total	Per cent Electric
1909	14,493,936	9,330,783	107,355	13,762	9,185			23,955,021	.58
1910	16,504,509	9 412,772	122,303	52,141	3,194			26,094,919	.2
1911	15,598,650	7,947,854	97,653	29,105	2,844			23,676,106	.123
1912	20,780,723	10,327,901	121,517	18,309	2,853			31,251,303	.058
1913	21,599,931	9,545,706	121,226	30 180	2,831			31,300,874	.096
1914	17,174,684	6,220,846	89,869	24,009	3,622			23 513 030	.102
1915	23,679,102	8,287,213	113,782	69,412	1,527			32,151,036	.216
1916	31,415,427	11 059,039	129,692	168,918	604			42 773,680	.395
1917	34,148,893	10,479,960	126,716	304,543	495			45,060,607	.675
1918	34,459,391	9,376,236	115,112	511,364	329	1,496,891	290,961	46,250,284	1.74

capable of producing 1,215,000 short tons. This is the possible production on an eight hour day basis, provided there are no interruptions. For continuous operation of 24 hours per day it would pe possible to average five heats per day on castings and ingots, taking into account delays for repairs. On this basis the annual capacity would be 2,025,000 short tons.

Table of Electric Steel Furnaces.

By countries of the world installed or contracted for on January 1, 1919, with totals for 1918, 1917, 1916, 1915, 1913 and 1910. Based on figures published by "Iron Age."

	Total Jan. 1 1919	Total Jan. 1, 1918	Total Jan. 1, 1917	Total Jan. 1, 1916	Total Jan. 1, 1915	Total July 1, 1913	Total March 1910
Germany and Luxemburg	...	91	52	53	46	34	30
Austria-Hungary	...	31	18	18	18	10	10
Switzerland	...	4	4	4	3	2	2
Italy	...	40	29	22	22	20	12
France	...	50	29	21	17	13	23
Great Britain	...	131	88	46	16	16	7
Belgium	...	...	3	3	3	3	3
Russia	...	21	16	11	9	4	2
Sweden	...	50	40	23	18	6	5
Norway	...	12	9	6	2	3	...
Spain	...	2	2	2	1	1	...
Japan	11	4	2	1	1	1	...
South Africa	...	2	1	1	1	4	3
Australia	2	1	1	1	1	...	...
Chile	3	2	...	1	...	...	...
Denmark	...	2	1	...	...	...	...
Brazil	2	...	...	...	...	...	...
India	1	...	...	...	...	...	...
Location not given	...	21	21	9	12	...	...
*Total outside the United States and Canada	...	464	316	222	170	118	101
United States	287	233	136	73	41	19	10
Canada	43	36	19	8	2	3	3
Total in the United States and Canada	330	269	155	81	43	22	13
Grand total in the world	815†	733	471	303	213	140	114

The increase from 155 electric steel furnaces in the United States in 1917 to 330 in 1919 is about 113 per cent, and the increase from 1910, a period of nine years, is about 2,500 per cent.

Among the chief reasons for this phenomenal growth in the electric steel industry should be mentioned the following:

1. The electric furnace met the demand for a more scientific way of producing uniform steel.

2. The results obtained in general average practice indicated that the electric furnace steel was uniformly better by a startling percentage.

3. Due to the fact that electric steel can be poured at a much higher temperature in a still or dead condition, it has become possible to produce intricate thin section castings with regularity and without high percentage of rejections. As a result electric steel castings are now used in many fields not open to steel castings heretofore.

4. Quality of electric furnace steel offered a possibility of applying a distinctly new atmosphere to the sales work. This was directly in line with the demand for quality products of all kinds which has grown up in the past few years. The demands of the government on account of war-time requirements and the development of new fighting machinery brought out requirements which could only be met by the electric furnace. This naturally stimulated the industry and placed it on a firm foundation.

In addition to those furnaces, which are used for the production of various grades of steel, there are about 85 electric furnaces of different types in the non-ferrous metal trades and about 100 in the ferro-alloy industry. The growth of the electric furnace method of production in these two fields has been phenomenal. Four or five years ago there were no electric furnaces used commercially for the production of non-ferrous metals, and since 1914 the number of ferro-alloy furnaces has been more than doubled.

Editor's Note—An article entitled "Electric Furnace Developments During 1919," appearing in the January issue of The Blast Furnace and Steel Plant, page 45, gives the following information of ininterest to this subject:

At the expiration of the year just passed, there were some 20 different concerns manufacturing or selling various makes of electric furnaces in the American markets. This is an increase of perhaps five over that of the year previous. The new concerns, however, include those turning out furnaces for non-ferrous metals, as well as for steel making. While authentic data is not available regarding the actual number of furnaces sold or contracted for during the year, it is safe to assume that approximately 45 electric steel making furnaces were either placed in operation or contracted for in the United States and Canada. This is a marked increase when the limited period of development of the electric furnace is compared with the time other common processes have been in use.

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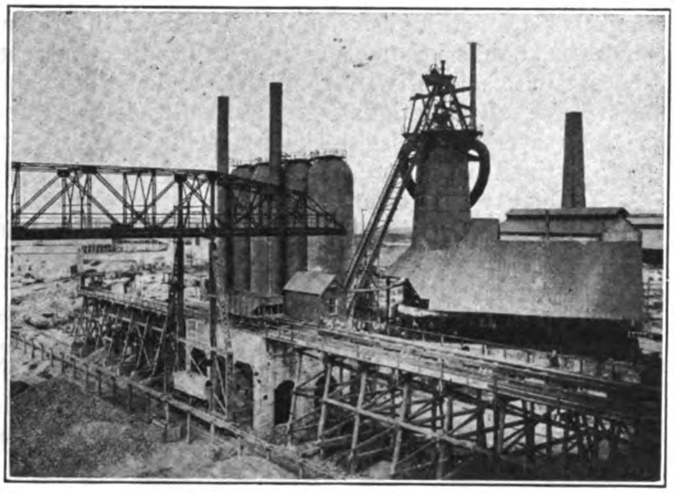
*Largely estimated on January 1, 1918.

†Obtained by adding the known new installations to the estimate for January 1, 1918.

Panoramic view of blast furnaces and steel plant of the Broken

Australia Independent
Natural Resources

Broken Hill Proprietary Company's
Originally Patterned After American
Necessary Iron and Steel and



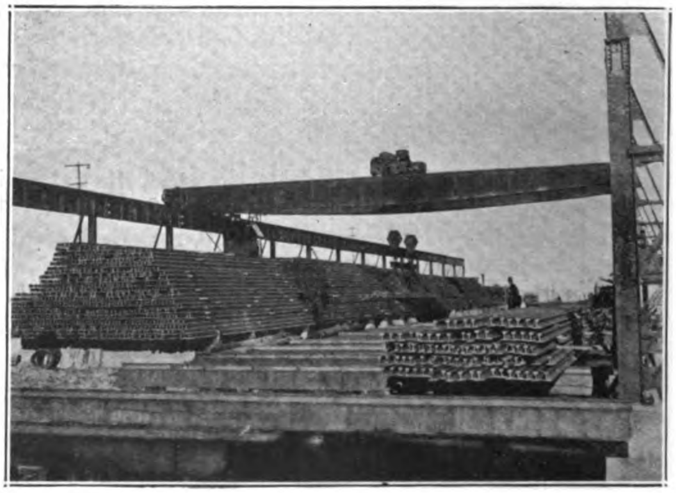
View of No. 1, 350-ton blast furnace.

THE realization that next to food and clothes nothing is more necessary to the needs and well-being of a progressive nation than an adequate supply of iron and steel has taken firm root in the commonwealth of Australia, where, when present improvements and additions are completed, there will be two up-to-date plants producing most, if indeed not eventually all, of Australia's requirements in iron and steel products.

Although steel has been manufactured for some 30 years at Lithgow, N. S. W. (about 100 miles from Sydney) ideally located in the heart of the famous Blue Mountains, with abundant coal, ore and limestone near at hand, the plant there, now controlled by G. & C. Hoskins, Ltd., and undergoing extensive alterations and improvements so that shortly it will be a splendidly modern steel works of 3,000 tons weekly capacity, has been inadequate to supply Australia's requirements. But for the foresight of the owners of the Broken Hill Proprietary Company, Ltd., who despite the pessimism of many, embarked upon the construction of a gigantic steel plant in 1913 the commonwealth would have very materially suffered during the war, particularly in the matter of rails. Situated many thousands of miles from steel producing countries, whose energies were concentrated on the production of vital war needs, Australia would have been badly hampered in the carrying on of necessary construction had she been forced to rely on steel from former sources of supply.

Long a factor in the development of the continent's mineral wealth, the Broken Hill Company had acquired, in connection with its smelting operations at Fort Pirie, South Australia, whence the lead from its mines at Broken Hill, S. A., is brought, large deposits of iron hematite ore. These deposits, located at Iron Knob, South Australia, are but a short distance from the coast, convenient for water shipment and besides being apparently inexhaustible, are exceedingly rich, yielding on an average 66 per cent of metallic iron. So, that with the acquiring of large quantities of limestone at Devonport, Tasmania, also near seaboard, two of the primary requisites were at hand.

Having as early as 1890 acquired an extensive site



Rail stock yard.

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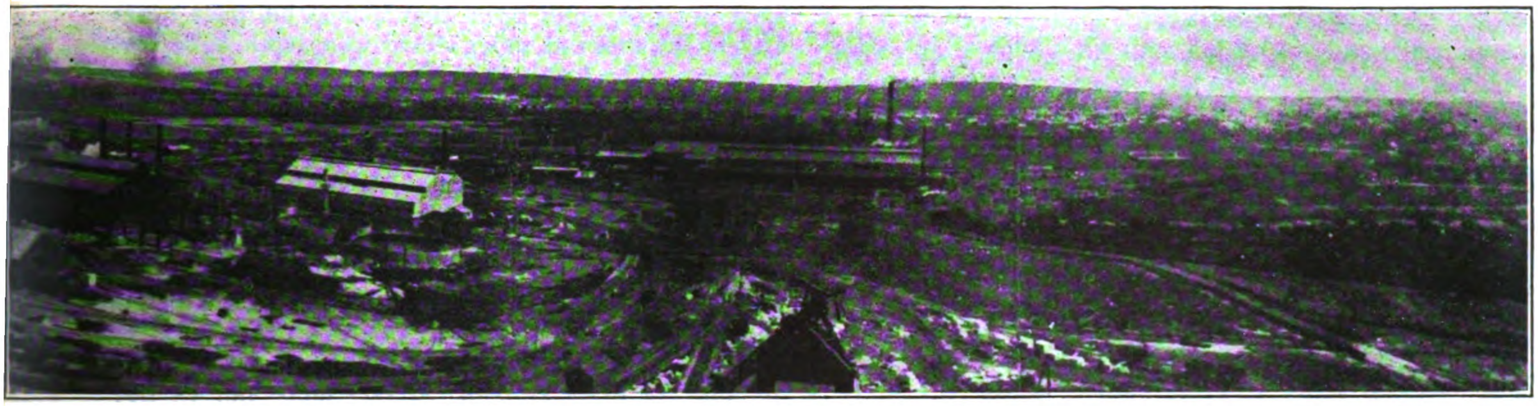


Hill Proprietary Company's plant at New Castle, N. S. W., Australia.

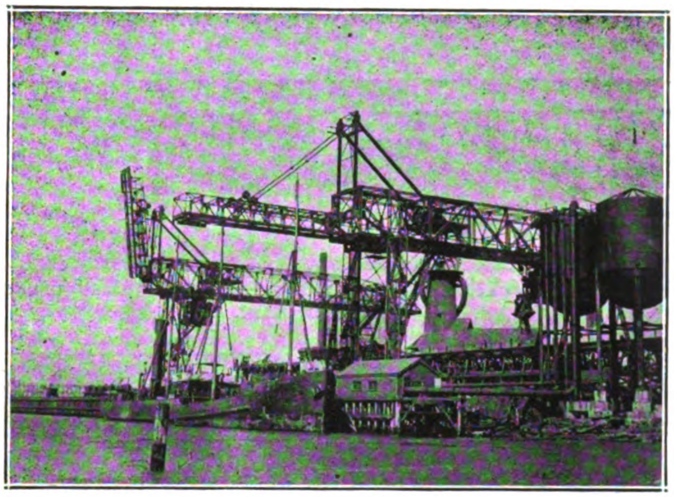
Steel Nation Due to and Modern Mills

Blast Furnaces and Steel Plant Practice Supply Australia With Semi-Finished Steel Products.

at Newcastle, in the heart of Australia's richest coal region, which as time goes on bids fair to outrival its famous prototype of the mother country, it was decided to bring the ore to the coal, as was done in Pittsburgh years before, and accordingly in January, 1913, under the direction of David Baker, formerly of the firm of Ladd & Baker, Consulting Engineers, Philadelphia, Pa., construction of a steel works, with an initial capacity of 120,000 tons of steel per annum, was commenced.

Starting with one 350-ton blast furnace, brought from America, four 65-ton basic open-hearth furnaces, a battery of 66 Semet-Solvay by-product ovens, a blooming mill, rail mill and three bar bills, the success of the works after their formal opening in June, 1915, was such that almost immediately it was decided to increase their capacity, with the result that today, only a little over four years after the opening, the works at Newcastle are producing 5,000 tons weekly, in which amount is included sufficient rail tonnage to take care of the entire requirements of Australia's five states.

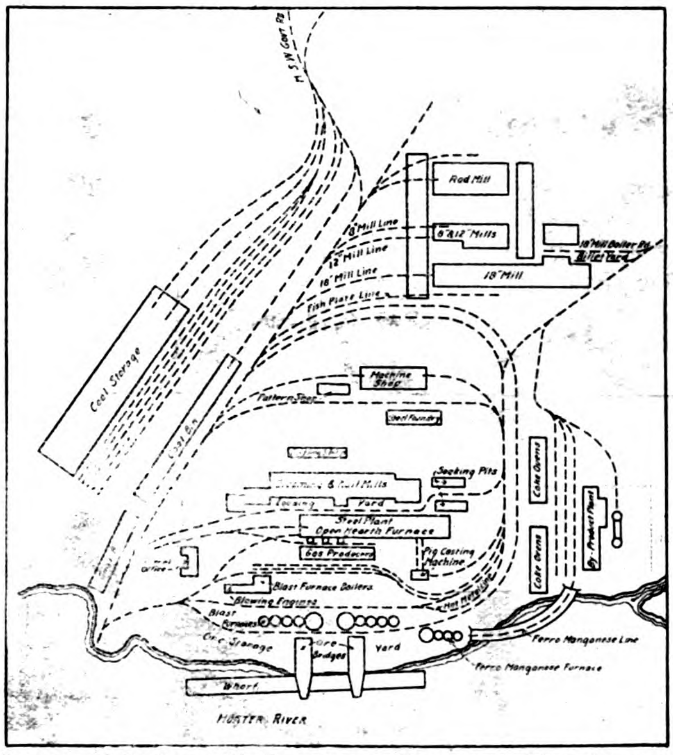
Pig casting machine for taking care of overplus iron.



View of wharf showing ore bridges.

Although much of the original equipment of the works was brought from America, from which country also the latest practice has been inaugurated, under the direction of Mr. Baker and several American assistants, the additional 350-ton furnace, which was blown in late in 1918, as well as a 100-ton furnace, now running on ferro-manganese, have been entirely built at the Newcastle works. A Morgan Construction Company continuous rod mill, with 16 pairs of rolls, has also been installed, and has been in operation since late in 1918.

Situated on the Hunter river, at a point called Port Waratah, about 1½ miles from Newcastle, the site of the present works was originally a swamp and the present ground reclaimed by sand dredges, practically all of the buildings, as well as foundations for the heavy machinery being erected on piles as well as concrete bases. Most of the land was then under water. The bank was marked by a ridge of mud, within which water oozed and fell according to the state of the tide. In order to drive the first pile for the foundations of the blast furnace, a punt with a pile driver and engine was floated to the site of the



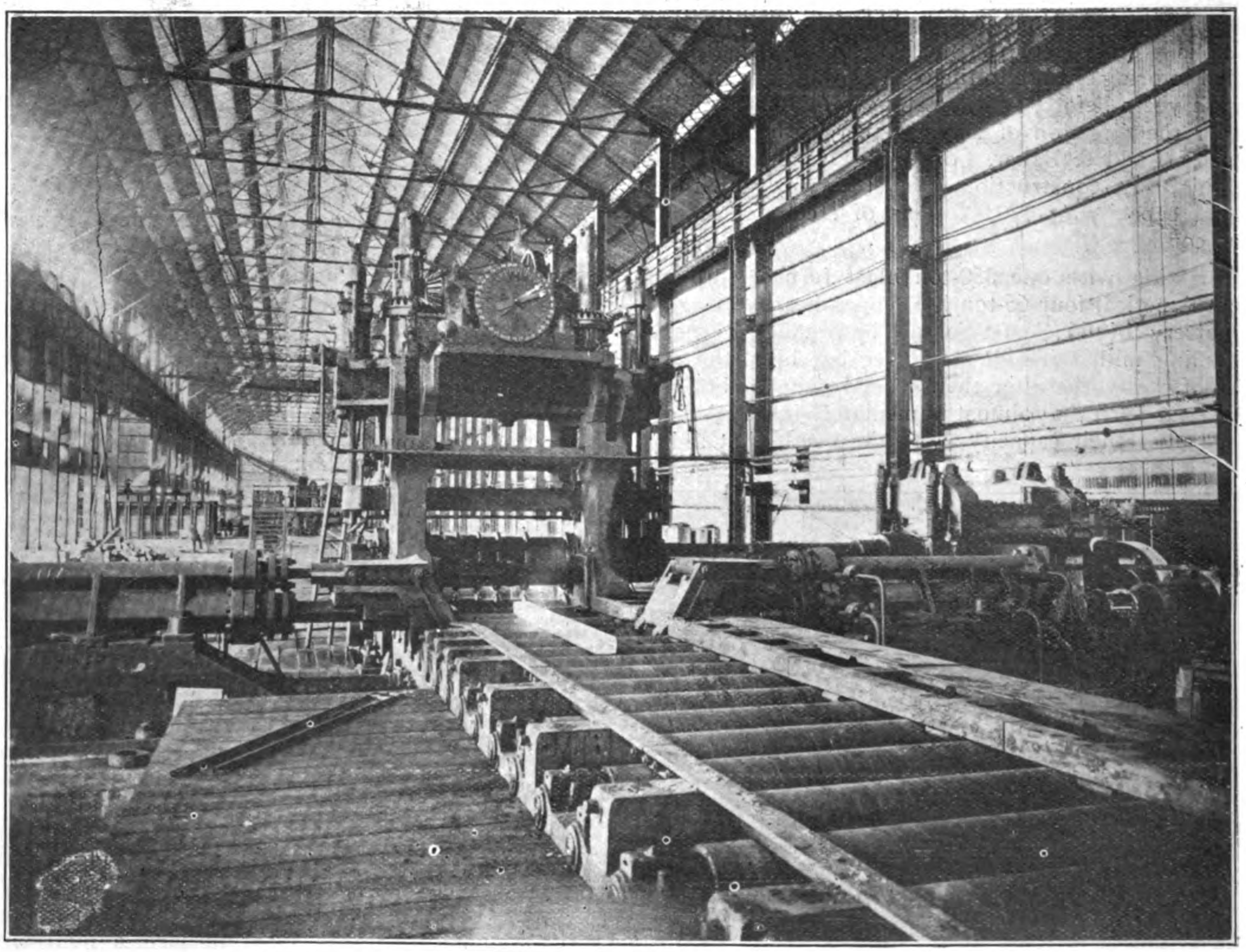
Layout of Broken Hill Proprietary Company's blast furnaces and steel plant.

blast furnace, and from that point the piles were driven, the first one going down to a depth of 31 feet 5 inches. The water here was about 2 feet 6 inches deep. Piling proceeded steadily, the ultimate location of the blast furnace being underpinned with 225 piles in 15 rows of 15 each.

Were the heating stoves are erected nine rows of 38 piles were put down. Everywhere at which it was intended to build heavy structures the foundation was raised on piles.

For instance, the foundation of the blast furnace, begun in the early part of May, 1913, is a concrete block 44 feet square and 17 feet thick; the stove foundations are 132 feet long, 29 feet wide and 15 feet thick. The engine that runs the blooming mill is laid on a concrete mass measuring 3,000 cubic yards; the engine for the rail mill is similarly buttressed, while the remarkable steadiness of the building holding the machinery working the blowers, notwithstanding the huge horse power developed, is due to the solidity of the base on which the engines are reared.

The Hunter river has been dredged to a depth of 35 feet, so that ocean-going vessels, bringing in the ore and limestone from the neighboring states of the commonwealth, are enabled to proceed directly to the huge 1,300 foot wharf, which is served by two giant ore bridges, 240 feet long, 60 feet high and equipped



Thirty-five-inch blooming mill driven by 42 x 60 twin cylinder reversing engine.

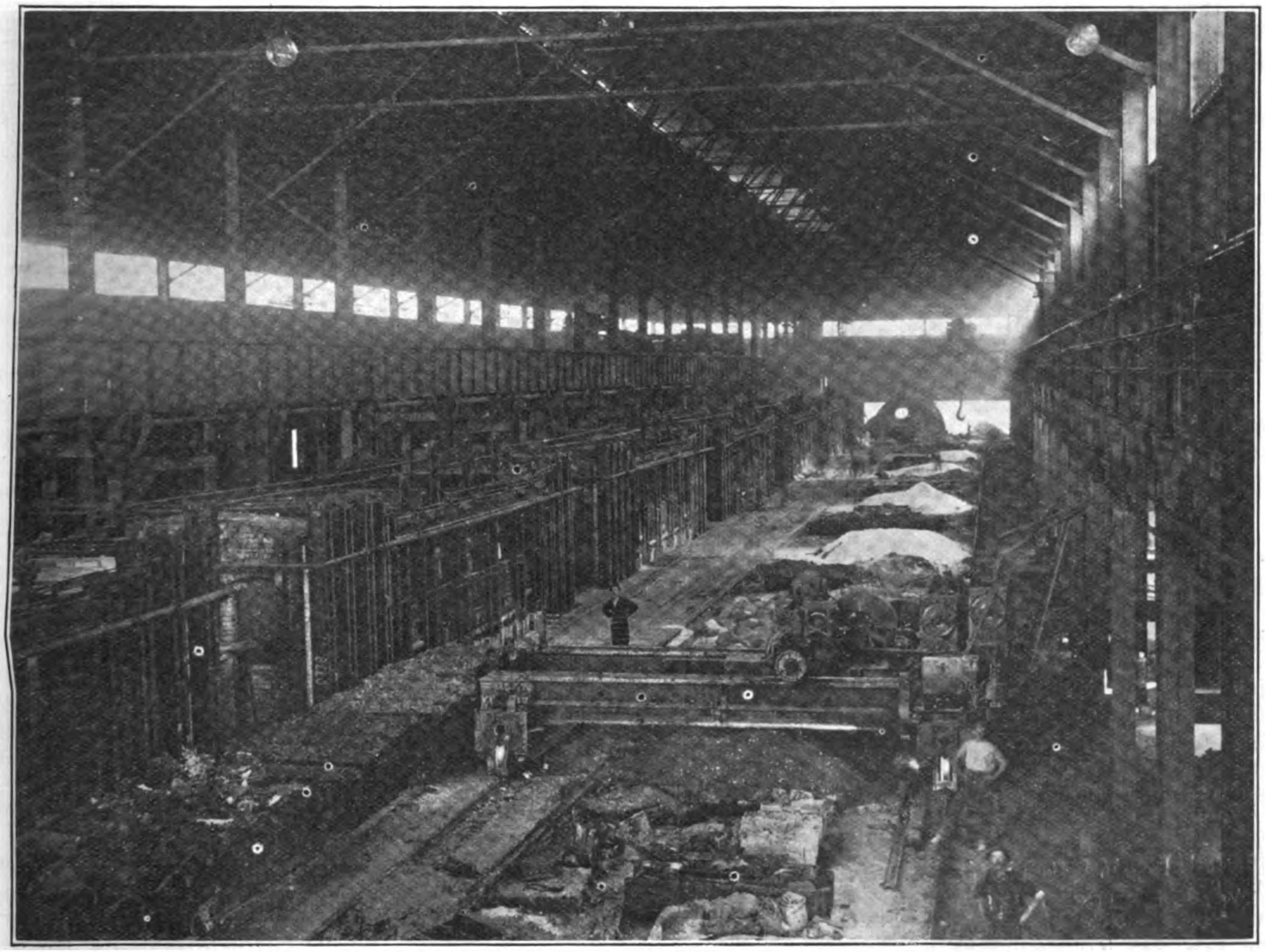
with a movable arm 82 feet long, unload their cargo, and reload with coal for the Fort Pirie smelters and for Tasmania at the adjacent coal storage wharf, where a coal bin capable of holding 5,000 tons of coal has been constructed.

The works have been very efficiently laid out, modeled somewhat on the lines of the Steel Corporation plant at Gary, and all materials is moved in regular progression from the time the ore and limestone is unloaded at the wharf until the finished steel is either placed in the steel storage yard or loaded aboard cars ready for its journey to supply the requirements of N. S. W. customers, or in steamers if destined for the other states of the commonwealth. Due to the lack of standard gauge existing on the various railroads of the continent (each state has its own government railway with an individual gauge, while in one state, South Australia, there are several gauges) rail shipment throughout Australia is not as yet possible.

The works might be quadrupled in size, and they would continue in the same orderly association from the wharves inward, without crowding, and using the same sources of transport, fuel and ore supply—all working with the utmost economy, and by a system of mutual interchange, achieving the highest efficiency at a minimum expenditure of power and labor.

The illustrations show the works as they appeared in 1915 with the exception of new blast furnaces shown in layout. Once the ore is unloaded by the ore bridges into the ore storage yard the blast furnace burden is assembled, conveyed to the blast furnaces, which are equipped with Baker-Newman rotary distributing tops (Mr. Baker is joint designer of this top) by inclined skips, and the hot metal, after each tapping proceeds on its way along the hot metal track, either directly to the open hearth furnaces (seven of 65 tons capacity) or to the pig casting machine. The open-hearth furnaces are served by an Alliance charger. Ore bins have capacity of 27,000 tons. Gas for open hearth furnaces is made in six Morgan (new type) gas producers. Ingots, measuring 20x22 inches are given 16 or 17 passes through the blooming mill, until an 8x8 inch bloom is produced, then (if intended for bar or rod mills) cut under 42-inch hot metal saw, and conveyed to the 18-inch mill. The blooming and rail mill building is 950 feet long by 75 feet wide. The rail mill is a 28-inch mill. There are three soaking pits, each capable of holding 24 ingots.

There are 132 Semet-Solvay type coke ovens producing five tons of coke from a charge of seven tons of coal every 22 hours, or a daily capacity of approximately 660 tons.



View of open hearth plant showing seven open hearth furnaces.

Heating Furnaces and Annealing Furnaces

Discussion of the Use and Application of Producer Gas in Heating Furnaces — Limitations of Producer Gas — Burners for Economical Combustion — Raw Gas and Clean Gas.

By W. TRINKS.

PART XIV.

IN the present day meaning of the term, producer gas is that gas which is obtained by blowing steam and air through a bed of glowing carbon. If air alone is blown through the coal, we obtain air gas, and if steam alone is blown through the coal, we obtain water gas.

The composition and the heat value of producer gas vary with several factors, particularly with the kind of coal which is used. If the fuel bed consists of anthracite or of well done coke, the gas contains very little tarry matter. If, on the other hand, bituminous coal is charged, its volatile matter is given off in the shape of a variety of hydrocarbons which condense by degrees, as the gas is cooled.

The gas coming directly from the producer is called raw producer gas. It is very frequently used for furnaces. In that case, producer and furnace (resp. furnaces) are placed as close together as possible, in order to utilize the sensible heat in the gas and the calorific value (combustion heat) of the uncondensed volatile matter. The gas flues between producer and furnace are brick lined. In spite of these precautions, some tar condenses and, in time, clogs the flues. The tar is, therefore, burnt out at regular intervals. Although this work involves some inconvenience, by far the greatest number of producer gas fired furnaces use raw gas.

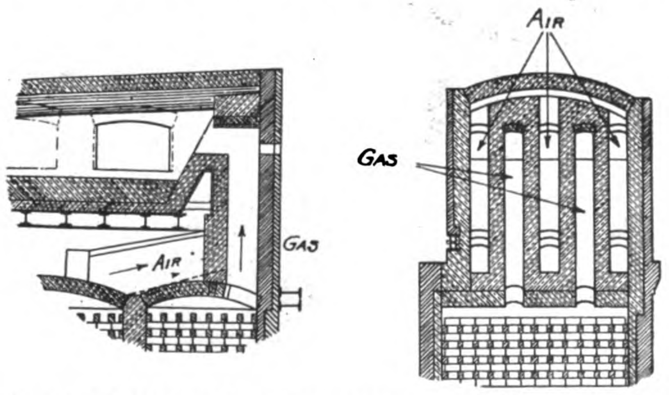
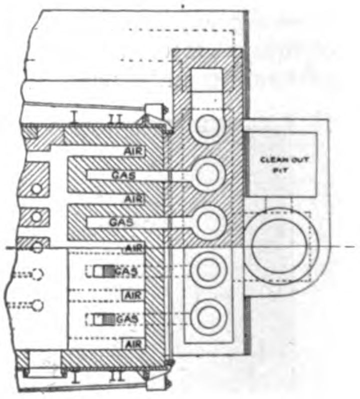


Fig. 99—Ports for air and raw producer gas in regenerative heating furnace.

If the necessity arises to place the producer plant at a great distance from the furnaces, or if many comparatively small and scattered furnaces are to be fed, the gas is cooled and cleaned. It is then known as clean producer gas. An outfit for making such gas is more complicated than the equipment used for making raw gas, consisting as a rule of gas producer, cooler, tar extractor, scrubber, and gas exhauster (driven by engine or motor). Clean producer gas has lost its sensible heat above that coresponding to atmospheric temperature, and can be transmitted through ordinary (not lined) steel or iron pipe. The low heat value of the gas necessitates rather large pipes, or else excessive power consumption for the pumpage, if the gas is to be transmitted several thousand feet.

Inquiring into the heat value of producer gas, we find that it is very low compared to other fuels. The high heat value of raw gas ranges between 150 and 180 Btu per cubic foot at 32 degrees F. and 30 inches mercury, varying of course with the coal from which the gas was made, and with the efficiency of the producer.



The cost of producer gas per unit of heat value is naturally of greatest importance. It is made up of the cost of the coal delivered, of its heat value, of the producer efficiency, of the first cost and the rate of depreciation, of the load factor, and of the labor connected with gasification. Evidently, the cost must vary within very wide limits. It would be very desirable to derive a formula which involves the above mentioned variables, but, unfortunately no such formula exists. Efforts to secure the coöperation of the builders of producers in the making of a formula have fallen flat. Everyone of them admits that his firm should have the formula for the benefit of the sales force, but that the engineering and accounting departments have been too busy with detail work to pay attention to a comprehensive formula. And yet such a formula, carefully and painstakingly developed, and including index factors for the cost of labor and

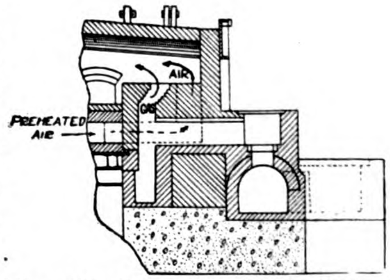


Fig. 100—Ports for preheated air and for raw producer gas in continuous slab furnace.

materials would cut down the cost of estimating on new jobs to a remarkable extent.

Under the present circumstances there remains nothing but to give patch work data, and to figure out each individual case upon its individual merits. The following data are available: Producer efficiencies range from 55 per cent (small producers, poor coal) to 80 per cent (large producers, good coal). From these efficiencies, from the heat value of the coal used and from its price, the cost of 1,000,000 Btu in the producer gas can be computed. To the cost thus obtained must be added a charge for the original investment and a charge for gas house labor. Labor and maintenance vary tremendously on account of the great variation in coal and handling equipments. At 1919 prices, (pig iron $33 per ton, labor 40 cents per hour) the cost of gas house labor for the most complete equipment and for a very large plant is estimated to be 15 cents per ton of coal gasified. For the average producer plant 45 to 60 cents is more nearly correct, while for small, poorly equipped plants the cost may reach $1 per ton. The cost of maintenance varies less, ranging from 4 cents to 6 cents per ton of coal gasified. To this must be added the cost of one-half pound of steam per ton of coal.

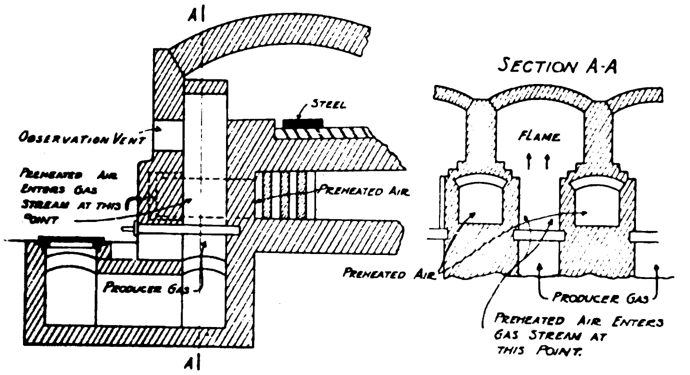

A
SECTION A-A
STEEL
OBSERVATION VENT
FLAME
PREHEATED AIR ENTERS GAS STREAM AT THIS POINT
PREHEATED AIR
PREHEATED AIR
PRODUCER GAS
PRODUCER GAS
PREHEATED AIR ENTERS GAS STREAM AT THIS POINT.
A

Fig. 101—Ports for raw producer gas and for preheated air in continuous billet furnace. Gas and air are delivered in just sufficient pressure to produce atmosphere pressure at observation vent.

The gasifying charge is higher for clean gas than it is for raw gas. The investment is greater, and the steam consumption is higher, because the gas must be forced through a cleaner. With 1919 prices, the gasifying charge per ton of coal, including interest, depreciation, producer labor, fuel for steam, coal and ash handling, boiler house labor, and pumping runs up to about $2 per ton of coal.

One of the greatest drawbacks of the small, hand-poked gas producer is the variability of the composition of the gas. Usually the calorific value varies up to 20 per cent in a day, and up to 40 per cent in a week. The variation is due to the variations in, 1, depth of fuel bed; 2, depth of ash bed; 3, rate of feeding of fuel; 4, steam to air ratio; 5, wetness of coal. It is not intended to give here a theory of producer design and of producer operation, but attention must be called to this variation because it deeply affects the design and the operation of combustion appliances for heating furnaces. It is utterly futile to purchase and install high class burners on the injector system which are intended to maintain a neutral flame, if the heat value and the composition of the gas vary continually. If the latter is the case, the responsibility for correct combustion rests with the heater, which means that correct combustion is very seldom obtained.

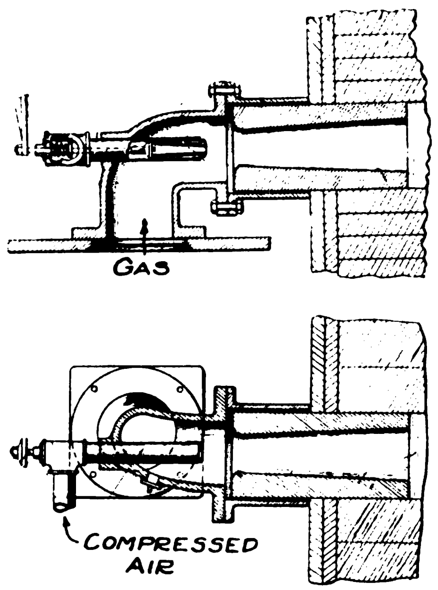


Fig. 102—Burner for raw producer gas.

In the installation of a complete producer and heating furnace equipment, special attention should, for that reason, be paid to the automatic and self-regulating features of the producer. Altogether too often the heating furnace and its appliances are blamed for the shortcomings of the producer. A continuous gas calorimeter for raw producer gas would be very desirable but no satisfactory instrument of that type exists at the present time (as far as I know) for raw producer gas, because the tar sooner or later clogs the burner of the calorimeter.

Producer gas is, as a rule, sent into furnaces through ports. Raw producer gas must not be throttled, because tar will accumulate at the place of throttling. For that reason it is best to have enough ports in the furnace so that some of them can be shut off altogether. Raw producer gas often arrives at the furnace with a temperature of 1,100 degrees F. or more. For that reason the shutoff valves are frequently of a water cooled type.

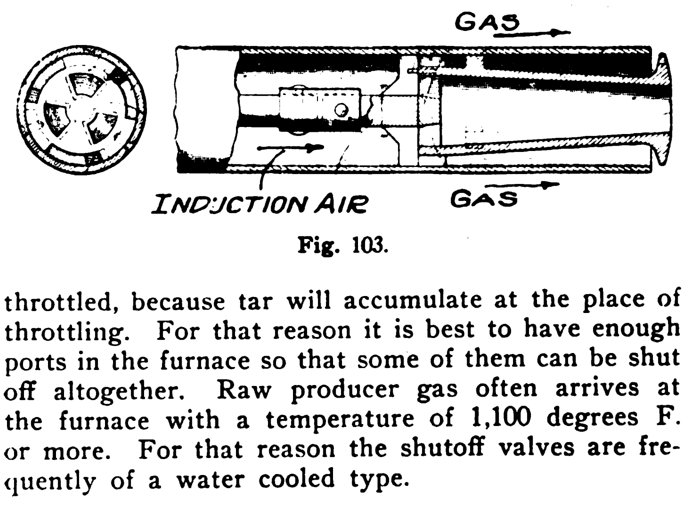


Fig. 103.

Fig. 99 shows how the gas and air ports are arranged in a regenerative heating furnace (bridge furnace), while Figs. 100 and 101, illustrate the arrangement of ports in furnaces of the continuous type. In all cases the ports are warm, or still better, hot, so as to avoid condensation of tarry matter. Standard sizes of brick impose certain limitations on the ports. They are never narrower than 4½ inches and seldom wider than 9 inches. In consequence, the flame is quite long. Preheating of air, or of both air and gas, quickens the rate of combustion. If the air ports are large and if the mixing of the gas and air in the ports is not accomplished, it is advisable to bring the gas in below the air, for the purpose of protecting the steel from scaling.

Very few successful burners for raw producer gas exist. The best is generally conceded to be the burner which was developed by Flinn & Dreffein, Chicago. It is illustrated in Figs. 102 and 103. The gas valve which is operated by the two handwheels, is either wide open or dead shut. The second handwheel is for the purpose of separating the valve from the seat after the burner has become cold. In that case the cold tar resists the opening of the valve.

The gas valve and its operating mechanism are not shown in the line drawings, Figs. 102 and 103. The flow of gas is regulated by the inducing effect of the air nozzle, and the inducing effect of the latter is varied by the twisting of a clover leaf valve in the nozzle. This valve directs the air either through the center of the nozzle or around the outside. The air passing through the center of the nozzle produces a strong inducing effect, whereas the air passing around the outside has a tendency to back up and hold back the gas. If, in addition, a throttle valve is provided in the air line, the total quantity of gas induced and the gas to air ratio can be regulated. The gas and air mixture pass through a combustion tube of refractory tile. All tarry matter is thoroughly gasified and made ready for combustion in the combustion tube. Hand holes for cleaning the burner are provided.

Clean producer gas can be burned with less precaution than raw gas. It can be sent through small ports or can be premixed in nozzles of the "Keith" or of the "surface combustion" type. A continuous calorimeter can be used with clean gas, and variations of heat value can, by the use of such an instrument, be kept down to a very small value. If the heat value is constant, entraining nozzles of the types mentioned give very uniform and very satisfactory neutral flames.

Producer gas is particularly well adapted to use in regenerative furnaces. It does not break up by being heated; without regeneration, ignition is difficult, combustion is slow, and the flame temperature is low. The ratio of the volume of gas and air chambers is usually 2:3. For size of these chambers, see Part 8, 1919.

Producer gas is a very useful fuel, but has its limitations. Its best applications occur in continuous operation and fairly large furnaces. In small furnaces and for very intermittent work it cannot compete with oil on account of the cost of the installation of a producer and on account of the labor connected with gasification. On account of its low flame temperature, producer gas gives a soft penetrating heat which is particularly desirable for large annealing furnaces. This statement should not be misconstrued into the belief that producer gas is undesirable for high temperature furnaces. On the contrary, quite high temperatures can be obtained by the regeneration of both the air and the producer gas.

Special Applications of Metal-Radiography

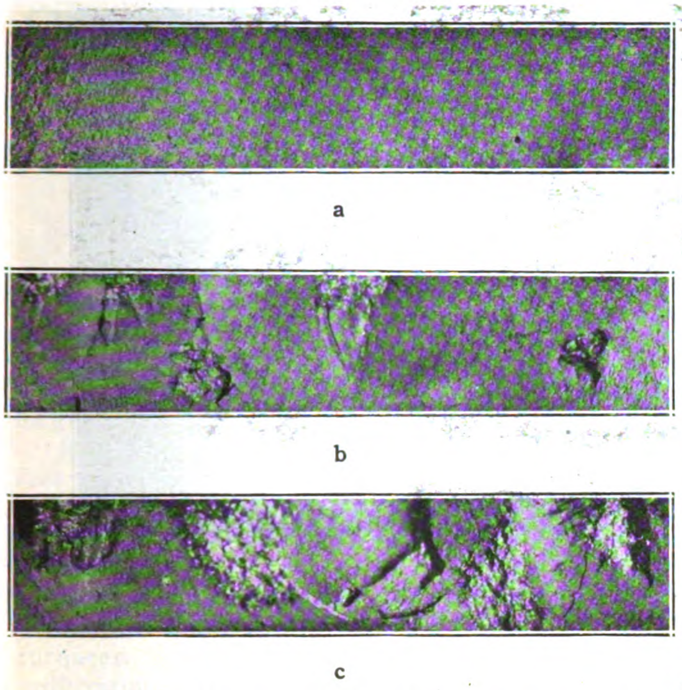
Study Shows That Proper Heat Treatment Alone Is Not Sufficient to Remedy "Flake" Defects—X-Ray Applied to Examination of Specimens for Impact and Fatigue Tests.

By HENRY S. RAWDON,
Physicist, United States Bureau of Mines.

THE following paper is a discussion of a paper by W. E. Ruder, which was published in the December, 1919, issue of THE BLAST FURNACE AND STEEL PLANT, page 589. The author prepared this discussion for the last meeting of the American Iron and Steel Institute.

The clear explanation of the production and nature of X-rays and the definite and explicit description of their use in the radiography of metals as presented by Mr. Ruder, leaves very little to be said concerning the technique and manipulations necessary for success in this particular application in the study of metals. In general, the results of the work along this line done by the Bureau of Standards confirm those described by Dr. Ruder.

The bureau has been limited to apparatus of the 100,000 volt (10 inch spark gap) type mentioned, hence it has not been possible to attempt readily, with any hope of success, the examinations of specimens of steel whose thickness exceeded one inch. Most of the examinations have been made upon specimens considerably less than this thickness. Of course with lighter metals and alloys, e.g. aluminium and its light alloys, much thicker specimens may be used and very satisfactory results obtained. In the study of this class of metals the method appears to offer more possibilities than in the field of iron and steel. It is believed that some of the applications made at the



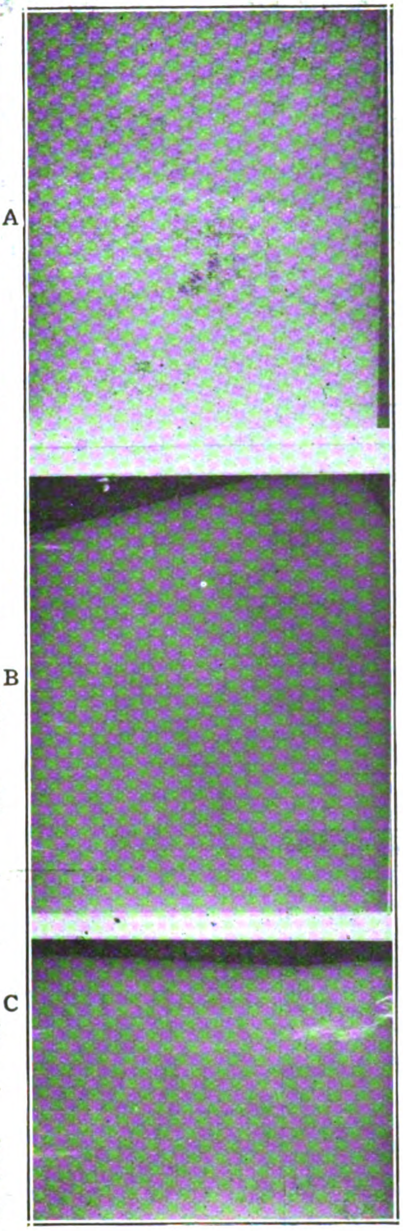


Fig. 1—Radiographic examination of test specimens and the corresponding fracture produced in fatigue test. Gun steel similar to that shown in Fig. 1 was used.
A. Radiographic examination revealed no flakes.
a. The fracture of the fatigue test specimen has the smooth porcelain-like appearance characteristic of sound material
B. The white lines correspond to interior flakes.
b. The coarsely crystalline areas in the face of the fracture are evidence of flakes.
C. This specimen contains numerous hidden 'flakes.'
c. The appearance of the fracture corresponds to the condition of the interior as revealed by the X-rays. X 2.
Conditions of exposure similar to those of Fig. 1.

Bureau of Standards of metal-radiography, working within the limits outlined by Dr. Ruder, are suggestive and interesting enough to warrant a short description here.

In the study of "flaky steel" with which most of us are familiar, unfortunately, it was desired to follow the behavior of material known to be defective through a series of heat-treatments without mutilating the material in any way. The claim has been made repeatedly that proper heat-treatment alone is sufficient to remedy the defect known as "flakes." Fig. 2 shows a series of radiographs of a specimen of gun steel, (carbon 0.38; nickel 2.92; chromium 0.20) after differend heat-treatments. The specimen, which was a transverse radial section of a finished gun-tube forging, was ⅜ inch in thickness. The three white circular spots were produced by drilling holes of the size shown nearly halfway through the specimen, these were needed as reference points for locating the various features revealed by the examinations. The four radiographs represent the material in the following conditions; a, the finished forged gun tube, i.e., as received; b, after annealing for 30 minutes at 900 degrees C., (1,475 degrees F.) and cooling in the furnace; c, after heating in a barium chloride bath for 30 minutes at 900 degrees C., (1,475 degrees F.) and quenching in oil; d, after heating for 30 minutes at 1,050 degrees C., (1,915 degrees F.) and quenching in oil. The series of radiographs show the gradual opening up of the defects. In many of the flakes in the initial or forged specimen the metal on the two sides of the separation was in such intimate contact that the intensity of the transmitted rays at the point was practically the same as that of those which passed through the adjacent sound metal, hence no evidence of the flakes was recorded on the photographic plate. The behavior of the defects during vigorous heat-treatment is shown by the increase in number and in definiteness of the white lines in the radiographs, which change can be due only to an increase in the width of the separation or fissures. The same method is to be used in the further study of this material to show the behavior of flakes in defective material when it is mechanically worked.

A similar application was attempted in the study of transversely fissured rails. The deep etching by means of concentrated acid of sections cut from the head of rails which have developed transverse fissures in service shows the presence of very serious defects. The presence of these defects in the material before etching had never been demonstrated and as a result a grave difference of opinion as to their seriousness and the real character existed. Longitudinal slices, ¼ inch in thickness cut from the head of a rail were examined by means of X-rays in the endeavor to locate such defects before the specimen was etched. Although the piece was known to contain these defects and their location had been definitely established by means of a magnetic method, no trace of their presence could be obtained by the X-rays. This confirms the third conclusion of Dr. Ruder that the detection of defects which if exposed to view, are invisible to the eye is very uncertain, if indeed, any indication is obtained. The method by which the defects were located in specimens, previous to etching, was to polish the surface as for microscopic examination, magnetize the piece, and then bathe it in a light oil, e.g. kerosene, containing fine iron dust in suspension. Wherever a discontinuity in the metal exists a change in the density of the magnetic flux results and the particles of iron arrange themselves so

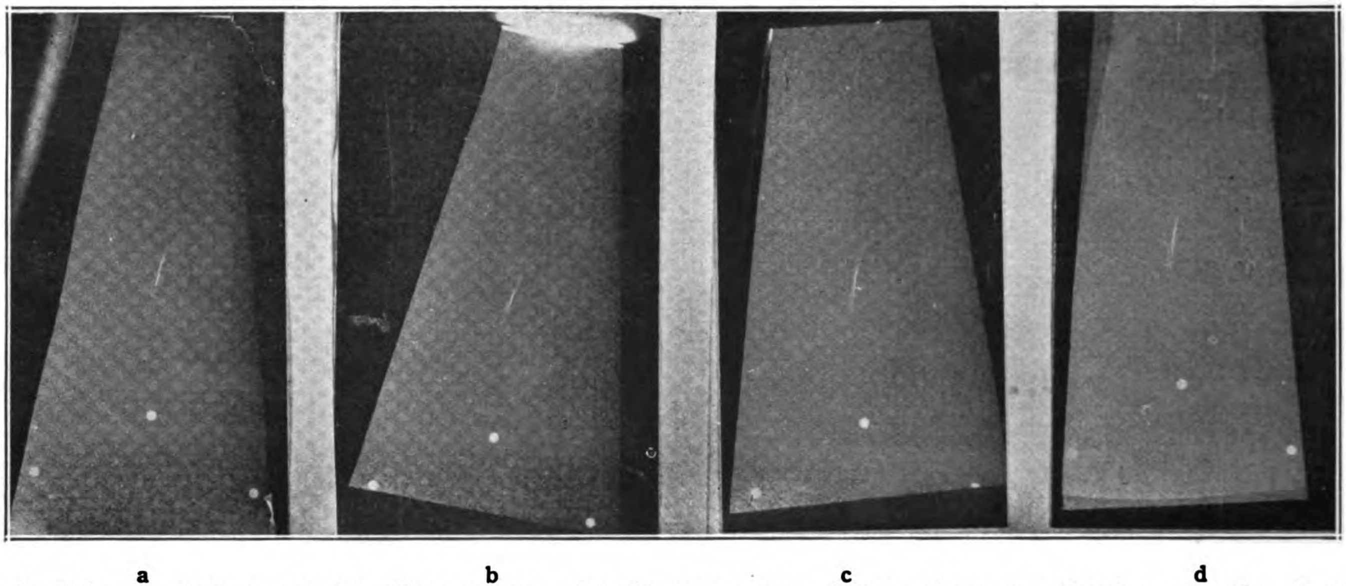


Fig. 2—Flaky gun steel examined by X-rays after various heat-treatments. The specimen was placed so that the direction of the rays coincided with the plane of the defects. Each white line represents a flake. The three white circles are reference points made by drill holes partly through the specimen.
a. Finished forging, as received.
b. Same after annealing 30 minutes at 900 degrees C, (1,475 degrees F.) and cooling in the furnace.
c. Same after heating 30 minutes at 900 degrees C., (1,475 degrees F.) and quenching in oil.
d. Same after heating 30 minutes at 1,050 degrees C, (1,915 degrees F.) and quenching in oil.
Note the increase in number and in definiteness of the white lines. Exposure, 9 inch spark, 2 milliamps, 7 minutes

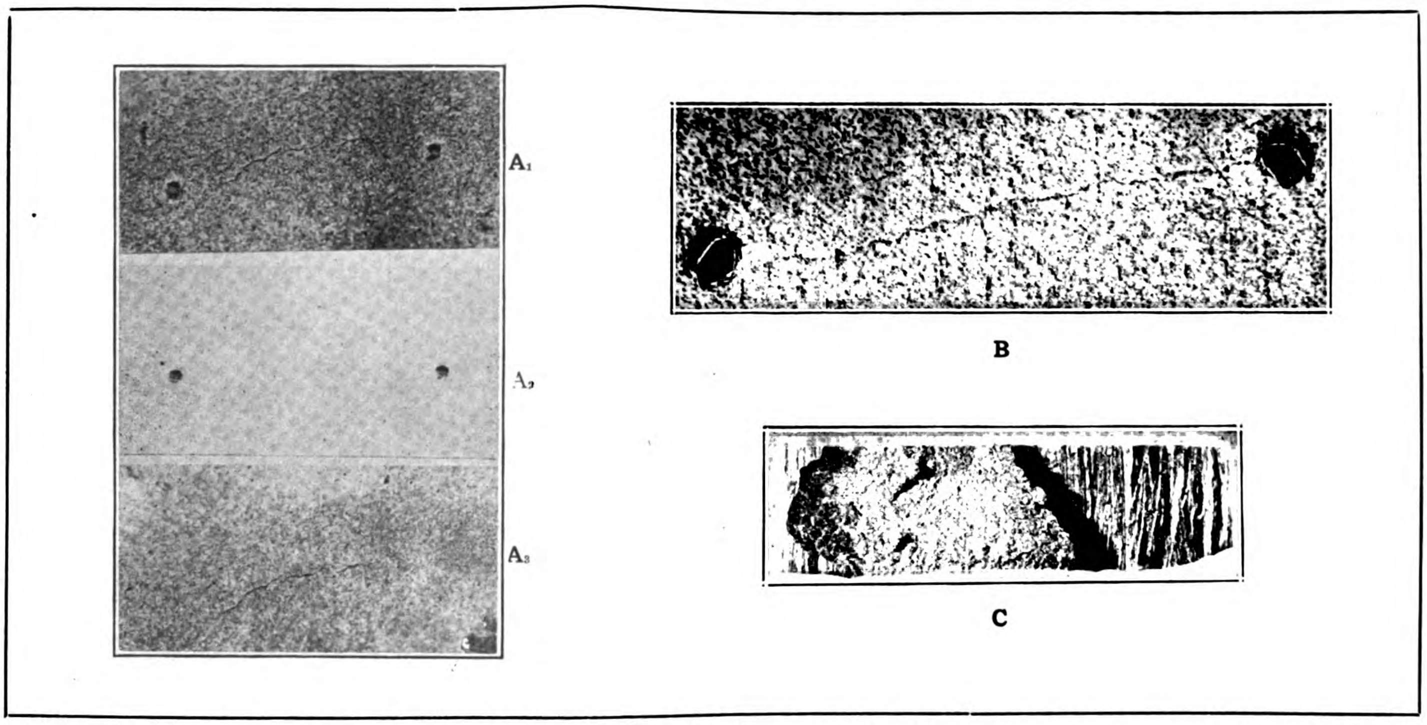


Fig. 3—Nature of the defects in transversely fissured rail heads. A₁. Located in the magnetized specimen by fine iron dust in suspension in oil.
A₂. Same specimen after locating the defect by a punch mark at each end and then wiping off the iron dust.
A₃. Same specimen, retreated with iron dust. X3.
B. Similar defect which has been opened up by means of two punch marks. The defect is really an internal fracture; the metal was in very intimate contact. X10.
C. Similar specimen. The material was broken transversely to reveal the interior fracture.
It was impossible to locate these defects by means of radiographic examination.

as to outline the shape of this discontinuity. Of course this method can be applied only to the detection of defects which extend to the surface. Fig. 3 shows the appearance of interior fractures located by this means. Although an actual discontinuity exists as was shown by cutting out sections and breaking them in two and is of such an extent that it must be regarded as a very serious defect, the metal is still in such intimate contact along the plane of the separation and the face of the separation is so irregular in its contour that the transmission of the X-rays here is the same as that

(Continued on page 171)

Steel Mill Coal Dust Explosion Hazards

Results of Tests and Investigations Made by the United States Bureau of Mines in Ascertaining the Liability of Coal Dust Causing Explosions.

By L. D. TRACY.

FOR many years natural gas has been the principal fuel used in the heating furnaces in those mills located in the Pittsburgh district which manufacture bolts, nuts, rivets, picks, mattocks and small forgings.

For a number of years the steady supply of this fuel has been more or less interrupted owing to the increased demand for domestic use and to the increasing difficulty in securing an adequate amount of natural gas.

This condition has led a number of the steel companies to substitute pulverized coal as a fuel for the furnaces. Elaborate installations have been made for pulverizing the coal and conveying it to the furnaces. Soon after the furnaces commenced to operate with pulverized coal, large quantities of fine dust began to accumulate on the platforms over the furnaces, the roof trusses, on the outside of the various pipe lines, electric cables and even on the roofs of the buildings.

Some of the companies, becoming alarmed, requested the Bureau of Mines to make an investigation to ascertain the liability of this dust to cause an explosion.

While conducting this investigation, an explosion occurred in another mill which caused the death of one man and severely burned two others.

Eleven samples of the dust (which for convenience has been termed "mill dust") from various locations in the different mill buildings were taken and submitted to chemical analyses, microscopic examination and also to flame and explosion tests.

From the chemical analyses it was found that the volatile matter in the dusts ranged from 6.3 per cent to 23.54 per cent, fixed carbon from 50.88 per cent to 67.08 per cent and ash from 22.29 per cent to 32.16 per cent.

Five samples of the pure coal dust, before passing into the furnaces, were subjected to a chemical analysis and it was found that the volatile matter in the coal ranged from 30.50 per cent to 36.81 per cent, the fixed carbon from 46.86 per cent to 52.48 per cent and the ash from 9.26 per cent to 21.84 per cent.

Under the microscope a sample of mill dust, which by chemical analysis showed 23.5 per cent volatile matter, was found to contain a very large proportion of very fine partially coked coal dust, a small proportion of fine or medium fine partially coked coal dust and some dust thoroughly coked. In addition, a considerable portion of yellow resinous appearing matter, some particles of carbon which might be termed soot and some small particles of ash were found.

A sample, which by chemical analysis was found to contain but 11.25 per cent of volatile matter, under the microscope showed only a relatively small proportion of medium sized partially coked coal dust and many thoroughly coked particles.

From these examinations and analyses it would seem that, for some reason, the pulverized coal was being blown out of the combustion chambers of the furnaces before it had been thoroughly consumed.

The several samples of dust were also subjected to tests to determine the pressure which might be exerted by the dust in a possible explosion, as compared with pure pulverized coal; this test was conducted in the Clement-Fraser apparatus (described in Technical Paper 141 of the Bureau of Mines). Briefly, this apparatus consists of a glass globe, possibly six inches in diameter, containing a small platinum coil which is electrically heated. A sample of dust is blown against the heated coil and the pressure of the resulting explosion is recorded by a pressure indicator In these tests about 0.003 of an ounce of pure pulverized coal was blown by about 8 cubic inches of oxygen under a pressure of 5½ inches of mercury against the platinum coil which had been heated to a temperature of 2,200 degrees F. The average pressure obtained was 14.5 pounds per square inch.

A sample of the dust, containing 23.54 per cent volatile matter, exploded in the apparatus with a recorded pressure of 10.21 pounds per square inch, a second sample containing 20.6 per cent volatile matter recorded a pressure of 8.7 pounds per square inch and a third sample with 15.91 per cent volatile matter recorded a pressure of 4.6 pounds per square inch.

It will be noted that the sample containing 23.54 per cent of volatile matter registered a pressure but little under that of pure coal dust.

When the small quantity of dust which was exploded is taken into consideration and a pressure of over 10 pounds per square inch is obtained, it will be readily seen that, with a large amount of dust exploding, the pressure would run much higher, if confined.

Further experiments to determine the explosibility of the mill dust were carried on in the dust explosion gallery of the bureau. This is essentially a horizontal wooden box, 6 inches deep by 6 inches wide and 14 feet long, made of 2-inch planks, held together by wooden clamps and iron rods, in such a manner that the top may be removed. A metal flap valve covers the back end of the gallery, the other end being left open. At uniform distances along the entire length of the floor of the gallery are 14 holes, into which are fitted ¾-inch pipe jets projecting vertically from a 2-inch horizontal pipe extending beneath the floor of the gallery. The back end of this pipe is closed by a cannon having a capacity of about one-fifth of an ounce of powder, the other end being left open. A loose metal disk covers the end of each jet leading into each hole in the floor of the gallery, thus forming a pocket for the dust, about one-tenth of an ounce, with which each hole was loaded.

Each hole was covered by a small square of coarse, heavy screen held in place by large washers bolted to the floor of the gallery. The purpose of this screen is to diffuse the dust into a cloud of more uniform density.

The gallery was loaded by pouring about one-eighth of an ounce of the "mill dust" in each of the 14 holes in the floor of the gallery. The squares of screen were then placed in position over each hole.

The cannon in the end of the horizontal pipe beneath the gallery was loaded with about one-sixth of an ounce of powder, and about a third of an ounce of loose powder was placed between the first two holes in the floor of the gallery. After the loading of the gallery had been completed, the top was bolted on and the electric firing wires connected. The explosion of the powder in the cannon served to raise a dust cloud and the loose powder was used to start the initial explosion of the dust cloud.

The cannon and loose powder were fired by means of electric spitters, the cannon being fired two seconds before the loose powder.

From experiments made in the Fraser apparatus, it was believed that the division point between explosibility and non-explosibility would be found in dust containing between 10 and 15 per cent volatile matter.

Two samples, one containing 13.45 per cent and one containing 10.99 per cent volatile matter were tested in the gallery. The first sample was found to be quite explosive, while the one containing 10.99 per cent is less explosive and would probably require an initial explosion to ignite it.

Tests were also made to determine the inflammability of the dust, one of these being the heating of a clay roasting dish, six inches in diameter, in a furnace to a temperature of 2,000 degrees F. When the dish had reached this temperature, about one-sixth of an ounce of "mill dust" was quickly dropped in a cloud upon it.

Another test was made by blowing a small amount of the dust in a cloud across the flame of a Meker burner.

These methods of testing were valuable as they were almost identical with the conditions in and around a steel mill where the red hot iron and steel are often in close proximity to clouds of dust.

Two samples containing 20.60 per cent and 23.54 per cent of volatile matter burned readily and with more or less explosive violence.

Three samples containing 11.5 per cent, 13.45 per cent and 15.91 per cent of volatile matter burned readily, but without the violence of the two preceding samples.

Two samples containing 11.25 per cent and 10.99 per cent of volatile matter were found to be slightly inflammable and one with only 7.17 per cent of volatile matter would not burn at all.

From the above described tests and from similar tests with dust from the steel mills of other companies, it has been fairly well demonstrated that the division point between mill dust which will explode and that which will not explode, is reached when the dust contains about 11 per cent of volatile matter.

A good example of the great danger from mill dust, caused by the use of pulverized coal, is the fire which occurred a few years ago in a plant in which there were a number of puddling furnaces, some of which used pulverized coal as a fuel. A draft of air blew some of the coal dust over some red hot iron or slag. The dust immediately ignited and communicated the flames to the roof trusses. These were covered with fine dust which caused the roof to burn so quickly that the men barely escaped in safety from the building.

Many of the systems distributing coal dust to the furnaces consist fundamentally of fans which drive the dust from the storage bins through large pipes, from which small feed lines lead to the burners. It is the practice in some mills, when the furnaces are shut down, to stop the fan before all the pulverized coal in the pipe line has been thoroughly blown out. This is a rather dangerous practice for the reason that, when the pressure from the fan is stopped, there is liable to be a back draft from the furnace which may take live sparks into the feed line. These sparks will smoulder until the fan is started again and then will be fanned into a flame, igniting the dust in the feed line with a consequent explosion. The fatal explosion mentioned in the first part of this article was evidently caused in this manner.

The roof trusses, pipes, platforms and all other places upon which any considerable amount of dust might accumulate should be kept thoroughly cleaned. In cleaning these trusses, platforms, and so on, no flame torches or open lights should be used because of the danger of igniting any dust cloud which might be raised.

All electric switches and motors should be kept from dust and all electric wiring should be kept away from any place where dust in large quantities is liable to accumulate. As far as possible the wiring should be carried in conduits.

In some of the furnaces in which natural gas has been used, it is customary to keep both the gas and pulverized coal connections ready for service. If coal is being used, the gas connection should be cut out as there is a chance that a leaky valve may allow gas to accumulate in the main coal feed and become ignited by a back fire from the furnace.

The substitution of powdered coal for natural gas in the heating furnaces of the steel mills is of comparatively recent date, and there is hardly any doubt but that the practice will become more general in its application as an adequate supply of natural gas becomes more difficult to obtain.

As the problem of mill dust and the consequent danger therefrom seems to be prevalent in some plants using pulverized coal, it would seem imperative that every mill official should take precautions to prevent loss of life and property by an explosion or fire from this dust.—United States Bureau of Mines, Reports of Investigations.

La-Belle Iron Works By-Product Plant

Description of Pioneer Installation of Koppers Oven in the Pittsburgh District—Bridge, 1,520 Feet in Length Built to Maintain Uninterrupted Fuel Supply.

BEING the first Koppers by-product coke plant in the Pittsburgh district, excluding Youngstown valley, is the distinction which belongs to the new 94-oven Koppers plant of the LaBelle Iron Works, located on the south bank of the Ohio River opposite the company's main plant at Steubenville, O. The plant which has two batteries, each of 47 standard Koppers 12¼-ton ovens and is planned to permit duplication, replaces beehive ovens formerly operated by the company at LaBelle, Pa.

It was the original plan of the owners to build the plant on the Ohio side of the river, adjacent to the Steubenville mills and furnaces, but the West Virginia site was decided upon when it was found impossible to secure enough land contigious to the present plant to allow room for future extensions. The choice of the West Virginia site added considerably to the cost of the plant. A great amount of extra foundation work was necessitated and a fill of 15 to 20 feet over the entire site was required to bring the plant to an elevation above the flood stage of the river. The ovens themselves were carried eight feet above the new level in order to bring the stack flues above the flood stage. In excess of 900,000 yards of filling material was placed on the site and more than 70,000 yards of concrete were used in the construction of foundations. Void wall construction was used in the oven foundation which extends to a depth of 28 feet below the oven matt, the voids being filled with granulated slag. Piers and curtain walls, were used in the foundations of all the buildings and the floors laid on a granulated slag fill. All underground conduits and piping were laid before the fill was made. being erected on concrete piers.

To provide traffic communication between the two plants and insure an uninterrupted supply of fuel for the furnaces, it was necessary for the company to erect and maintain its own bridge across the river. This structure, which is of the cantilever type, is 1,520 feet in overall length and consists of 400 foot girder spans, two 230 foot anchor spans and a main channel span 660 feet long. It was planned and built by the American Bridge Company, and is the first cantilever bridge ever erected without a traveler or creeper, a crane with 110-foot boom being used in its erection throughout. The supporting piers are of reinforced concrete, 120 feet high and were sunk to bed rock, a distance of 43 feet below pool level, the caisson method being employed.

An unique feature of the new plant is the coal handling system. The coal used, excepting a small percentage, which is mined in the nearby West Virginia fields and brought to the plant by railroad, is transported over the Monongahela and Ohio rivers from the Pennsylvania coal district. For this purpose, barges having a capacity of 350 to 600 tons are used, the barges being towed down the river in fleets of 6 to 10. Harbor facilities are provided where approximately 30 loaded barges may be tied up awaiting their turn at the unloading dock, while the same number of empties can also be accommodated. A track hopper handles the coal shipped in by rail and a storage yard of 100,000 tons capacity is provided to insure an adequate supply for use during the winter months when the river may be closed to navigation.

Coal is unloaded from the barges by two Heyl & Patterson traveling gantry cranes, with 100-foot bridge. These cranes are each mounted on four two-wheeled trucks and travel over a 20 gauge track, so that they may also be used to handle coal in the stock yard. They are equipped with 3½ ton buckets which have a hoisting speed of 500 feet per minute. The buckets are especially designed with a view to clean unloading in minimum time with minimum labor.

When unloading the crane remains stationary on the dock, the barge being moved along the dock by an electrically operated barge shifter. Under normal conditions the coal is dropped into a small hopper located on the dock. It is then fed through the bottom of this hopper onto a 30-inch conveyor belt which in turn discharges it into the track hopper. If it is desired to stock the coal from the river, empty cars are placed over the track hopper and the coal discharged from the conveyor into them.

Loaded cars are moved by means of a cable haul to one of the several unloading pits which are located every 125 feet along the entire length of the storage yard. From these pits it is transferred to the storage pile by one of the gantry cranes. When it is desired to use coal from stock this operation is reversed, the crane loading the cars which are then transferred to the track hopper and unloaded.

The unloading dock which is 100 feet long and has a 100 foot fender at each end was built by the National Contracting Company, of Cleveland, O., while the coal handling and storage yard system was designed and built by the Heyl & Patterson Co., of Pittsburgh, Pa.

From the track hopper, coal is carried by a short-length pan conveyor to a 36-inch conveyor belt which, driven by a 50 G.E. motor, travels on a 20 degree incline to the top of the breaker building where it delivers the coal to the Bradford breaker. From the breaker which removes the slate and sulphur the coal, having been reduced to 1½ inch lumps, is carried by a conveyor belt and discharged into the proper one of three mixing bins. From the mixing bins it is fed by gravity onto the mixer belts, the feed at each bin being regulated by adjustable gates so that any desired percentage of each grade of coal can be secured.

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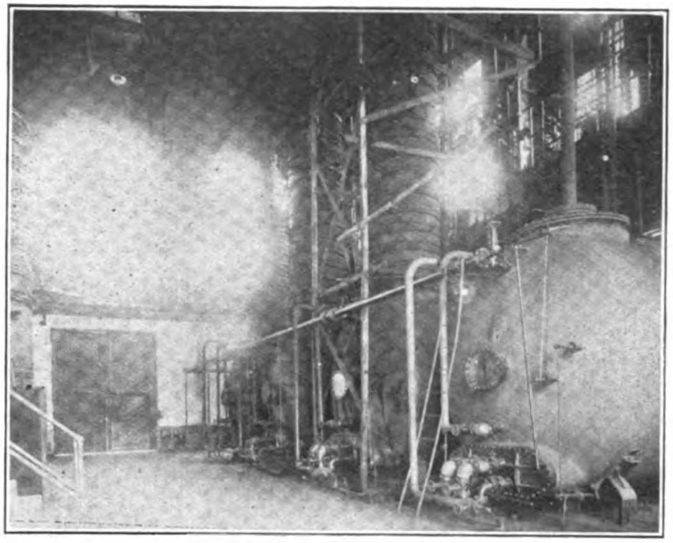


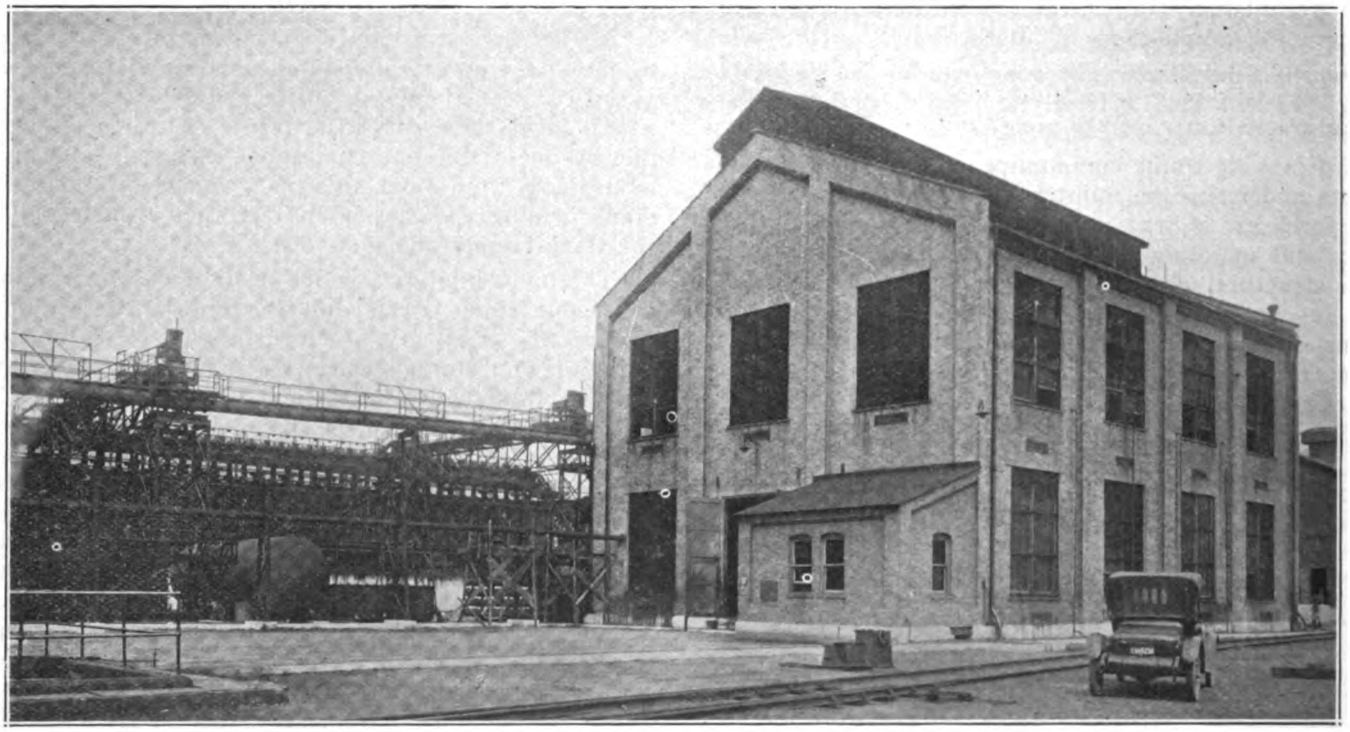
Interior of benzol building showing crude and pure stills.

The three mixer belts discharge into the same chute which leads to the hammer mills where the coal is pulverized to a fineness of 85 per cent through a $\frac{1}{8}$-inch screen. It is then elevated by conveyor belts to the 1,800-ton storage bin, located above the charging floor and between the two batteries of ovens. Robinson conveyor belt systems are employed throughout.

The chutes on either side of the hammer mills are equipped with rotary feeders which insure an even and constant feed and eliminate about 90 per cent of the dust which is so common about coal-handling plants. All the coal-handling equipment is indivually motored and the control is interlocked in such a way that no conveyor belt or crusher can be started or operated until the machine next in progression is in operation; in this way spillage or piling up of the coal if one machine should stop while the operator or attendant is not present is eliminated. Three-phase, 220 volt, alternating current is used throughout the coal handling plant which is equipped with General Electric motors throughout. All control boards for the various motors are housed in a separate control building which is located at a sufficient distance from the main plant that the delicate electrical control instruments may not be injured or incapacitated by coal dust; a push button located near each motor enables the operator to stop and start the machine at will.

The pulverized coal from the storage bin is fed by gravity into one of the two charging machines. The ovens are of the standard Koppers 30-flue type and the heating system is so arranged that gas is burned in the 14 flues at one end of the oven and the heated air and products of combustion pass out through the remaining 16 flues to the flue stack giving off heat as it goes. This arrangement is reversed every 30 minutes, insuring a continuous even heat at all times. This change is made automatically, the gas valves, stack dampers and draft dampers being controlled from the control house which is situated between the two batteries of ovens. The entire operating mechanism is governed by an electric clock, no attendant being required. The machines which operate these valves, and dampers are also electrically driven. In the central building is also located a Venturi gas meter for recording the gas consumed and all other necessary measuring devices for indicating the temperatures, gas pressures, etc.

The discharging, quenching and handling machinery is all standard Koppers equipment. The coke, after quenching and cooling, is dumped onto a wide wharf from which it is fed through gates onto a conveyor belt on which it is carried to the screens where



Benzol building showing wash oil coolers; circulating tanks and ovens in the background.

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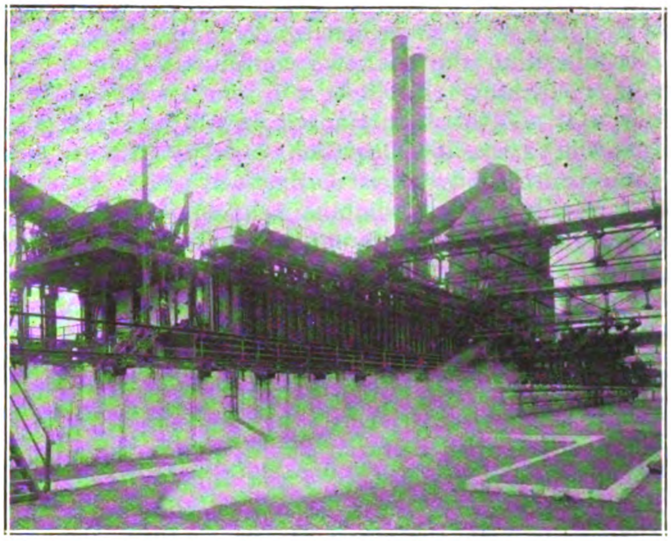
it is graded into various sizes. Part of it is transported across the river to the furnaces, part is sold for commercial consumption and the breeze is used in the power plant.

The by-product gas given off at about 1,000 degrees C. is collected in a 16-inch main through which it is drawn by two Connersville Blower Company, exausters of 128 cubic feet displacement, driven by a 250 hp Harrisburg Foundry & Machine Co., compound engine where it is cooled to about 28 degrees C. The sudden cooling condenses the tar vapor and the tar is run off into a settling reservoir. Here the gas liquors which are contained in the crude tar, being lighter than the tar itself, rise to the top and are drained off. The tar in this state is pumped to the nearby plant of the American Tar Products Company.

The gas, relieved of its tar content passes into the reheater where it is brought to a temperature of 60 degrees C., at which temperature it is forced into the saturator where the ammonium sulphate is removed and dosed in a centrifugal dryer, the ammonia liquor being distilled and the pure ammonia gas used again.

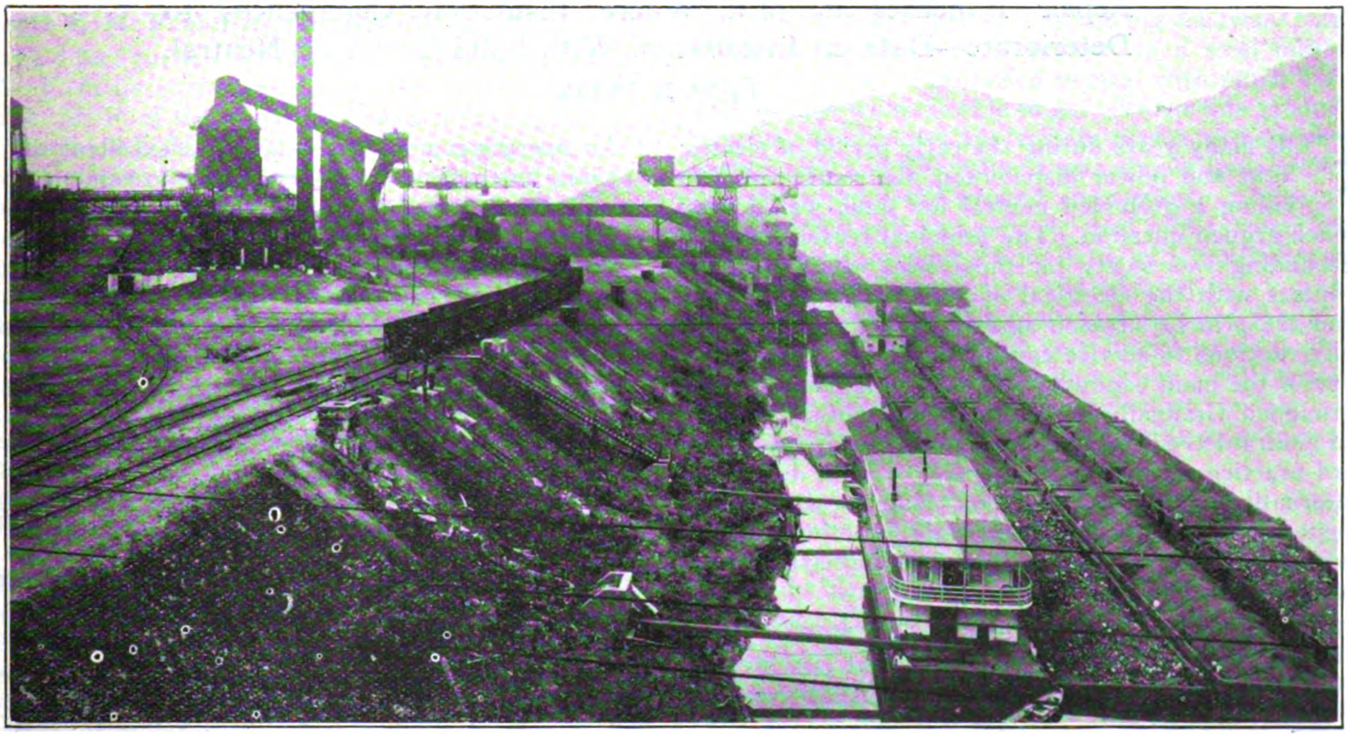
The by-product gas which comes off at about 800 degrees C. is collected in a main which runs the whole length of the battery and to which each oven is connected by a standpipe. A Connersville gas exhauster of 128 cubic feet displacement driven by a 250 hp Harrisburg Foundry & Machine Co. engine, draws the gas through a 30 inch main to the by-product building, where it first passes through water tube coolers and is cooled to about 28 degrees C. The sudden cooling condenses the tar vapors and weak ammonium liquor which is run into a settling reservoir and then pumped into a separating tank. Here the gas liquors which are lighter than the tar rise to the top and are drained off. The tar is collected in tar storage tanks and then pumped to the nearby plant of the American Tar Products Company.



Pusher side of ovens showing combined coke pusher and levelling machine.

The gas relieved of its tar content passes into the reheater where it is brought to a temperature of 60 degrees C. at which temperature it is forced into the saturator where the ammonium sulphate is removed and dryed in centrifugal dryers. The ammonia liquor is distilled in the ammonia stills and the ammonia vapor put back into the gas before it goes into the saturator.

The equipment of the by-product plant includes four water tube coolers, two tar extractors, reheaters, saturators, ammonia stills and six centrifugal diggers for the ammonium sulphate for which a 2,500 tons



General view of La Belle by-product coke plant showing loaded coal barges in harbor, coal unloading dock, coal handling and preparing plants and ovens.

storage room is provided. The benzol department is equipped with two final coolers and three benzol scrubbers for the gas, two continuous light oil stills for recovering the light oil, one crude still, one agitator and three fractionating stills for making pure product. Six 10,000 gallon capacity triplex Gould pumps are used for circulating wash oil.

The by-product pump house is equipped with three 15,000 gallon Gould pumps for maintaining tar circulation ,a tar loading pump of 10,000 gallons capacity, two 6,000 gallon hot drain pumps and two 6,000 gallon ammonia liquor pumps, all driven from line shaft by a 150 hp Westinghouse motor.

The water supply is furnished by nine artesian wells which were driven on the river bank. Each well is equipped with a Harris air lift pump, the air being furnished by an Ingersoll-Rand Imperial type 10 air compressor driven by a 200 hp Westinghouse motor. From the wells the water flows by gravity to a sump under the pump house and is circulated through the plant by two Gould single stage centrifugal pumps against an 80 foot head.

Two ammonia liquor pumps of 6,000 gallons capacity driven by 150 hp Westinghouse motors circulate the ammonia liquor through the stills. Six Gould wash oil circulating pumps with a capacity of 15,000 gallons per minute against a 180 foot head are employed in connection with the benzol scrubbers, while two 150 hp Westinghouse motored Gould single-stage circulating pumps with a capacity of 3,000 gallons per minute, against 120 foot head, pump the oil through the stills. The other pumping equipment in addition to two air compressors which furnish compressors which furnish compressed air for general use, include two 6,000 gallons capacity, a 250 hp Westinghouse motor-driven gas pump which pumps the surplus gas through a 16 inch main over the bridge to the Steubenville furnaces and a 200 hp Westinghouse motor-driven Ingersoll-Rand type 10 Imperial gas pump. All pumping machinery is electric motor driven, but is equipped with steam drive for emergency.

The power plant which forms a separate unit consists of four 400 hp Sterling water tube boilers which are fed by two Epping-Carpenter 12x7x12 boiler feed pumps. The boiler water is heated in a Cochrane feed water heater. The boilers are equipped to burn either gas or coke breeze, but the coke breeze is generally used being, burned on a Cox chain grate. Forced draft is used.

Electric current is supplied by the West Penn Power Company, from its Beech Bottom, W. Va., plant, being received at the plant at 22,000 volts, 60 cycle, 3-phase, and stepped down to 2,200 and finally to 220, by a series of Westinghouse transformers.

The General Electric motor generators, Type M. P. C., 6,500-200 Form L, 200 Amperes, are used to furnish the direct current required in the plant.

Other notable features of the plant include a model laboratory and office building, coal test building and service building which is equipped with individual chain hangers for the clothes of the employes, showers, toilet accommodation, etc.

Grounding the Neutral for D. C. System

Grounding Neutrals for Safety to Operators—Cutting Down Repair Expenses in Mill Where Insulation Commences to Deteriorate—Data on Installation With Solid Grounded Neutral.

By W. H. PRICE.

FOR many years during the early period of electric light and power distribution, the matter of providing a grounded neutral for same was a very much argued question. The principal reason for such grounding was safety for those who would come in contact with the electrical appliances, switches, etc.; and the principal reason against such grounding was interruptions to service caused by short-circuits when one of the main conductors or its connections became grounded. Gradually however, advocates of the grounded neutral have been winning—so that today it is standard practice to ground the neutral of both direct and alternating current distribution systems when these systems are provided with neutrals for other reasons, which are usually enforced on lighting systems, or combined lighting and power systems.

Grounding Neutrals for Safety to Operators.

Although the grounding of a neutral provided for a 250 volt direct current power system installed entirely for operating motors, would be an excellent thing for safety to those who are very likely to come in contact with live connections, such as trolley wires for electric traveling cranes in steel mills, as it would insure their not receiving a shock of over 125 volts to ground, I wish to call attention to another reason for such grounding, which I think is at least of equal importance.

Electrical Equipment in Steel Mills, Foundries etc. Receive Severe Insulation Strain.

Those who are responsible for the successful operation of electric motors in steel mills, about blast furnaces, foundries, and similar industries, know that the motors and controllers for such work must be of much better construction, not only in ruggedness, but also in insulation to live conductors. As everyone knows there are thousands of motors, motor starters, and motor controllers which give excellent service in many commercial installations, but which would not last very long in steel mill work If you were asked why this should be, nearly everyone of you

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Paper read before Birmingham section of the Association of Iron and Steel Electrical Engineers.

would among your answers say it is because of the hard punching and the dust in the steel mill that motors and control equipment break down. There is the answer, but it is not all of the answer.

Insulation Breakdowns in One Motor May Produce Similar Breakdowns in Other Motors on Same System.

It is true that the punching which electrical equipment gets in the steel mill is very severe, and it is equally true that the dust is always present in considerable quantity, but did you ever think that breakdowns in this type of equipment are contageous? Have you ever noticed that if a series wound motor in reversing duty service becomes grounded early in the week and you do not remove it from service until the following Saturday night or Sunday,—many other motors and control equipment broke down during that week? And if you had ground lamps connected, they frequently burst and burned up their receptacles. Nothing but excessive voltage could so burst these ground lamps. How did excessive voltage get on the system?

A Grounded Armature Is a Trouble Maker.

Let us suppose a 50 hp series wound motor used in hoisting duty on a soaking pit crane develops a grounded armature. This crane is not equipped with dynamic braking, but has a mechanical load brake, which is in poor adjustment, and allows the load to overhaul the motor in lowering. The operator plugs the motor in lowering to slow up the tongs over the steel ingot. When he does this the ground lamps on the system burst, but any other lamps connected across the power mains continue in service, and a close watch of them will show that instead of their brightening when the motor is plugged, they become dim. Here is the answer to the contagious motor breakdowns.

Counter E. M. F. and Accumulative E. M. F.

The direct current series motor generates a counter E. M. F. in its armature as any other type of motor. This E. M. F. of the armature ceases to be counter to the impressed E. M. F. when the motor is plugged, and is accumulative to the latter at such time, and assists it in drawing heavy current through the resistance in series with the motor, thereby making a very strong magnetic field in the motor. If the armature is spinning very fast in the opposite direction to which current is applied, which is the case with this soaking pit crane motor, it generates a very high voltage, which alternates in polarity between ground and the power system. It bursts the ground lamps, jumps across the mica insulation at the end of the commutators of motors running on the system, goes through controller insulation to ground and generally has the effect of lightning on the systems.

A Grounded Neutral Limits Rise in Voltage Between Conductors and Ground.

If the power system were provided with a neutral ground connection of large enough capacity to hold down the rise in voltage generated by the above soaking pit crane motor between power system and ground, much damage resulting to the other equipment could be eliminated. I have taken the case of the hoist motor on the soaking pit crane as an example because this is one of the most offending pieces of apparatus, but a series motor on a mill table could similarly produce these effects, although probably not as effective as the hoist motor which has a bad load brake that allows the motor to be overhauled and therefore be overspeeded. The faster the motor is going when plugged the greater will be the voltage generated in the armature when plugged.

Automatic Control Will Not Completely Prevent Insulation Strains From a Grounded Armature.

Manual control and automatic control of series motors both allow the above effects, but the latter is no doubt easier on the system than manual control, as it limits the current flow somewhat to the motor, and therefore limits the field strength and resulting generated armature voltage.

Means of Providing a Neutral for dc Systems.

Direct current systems fed by rotary converters can readily be provided with grounded neutrals, as a neutral on the ac side of the rotary will be the neutral to the dc side. But dc systems fed by two wire dc generators, should be provided with at least one balancer to obtain a neutral. It is probably best to provide a limiting resistance in the neutral connection to ground, for then an accidental ground to one of the mains or its connections will not put the system or part of it inoperative, or at least I think the most of you will believe in such a limiting resistance; but I have tried grounding the neutral solidly, and the results are excellent. A grounded motor or controller then must be taken out of service at once, and with a solid neutral ground there cannot be any appreciable rise in voltage between any of the dc conductors and the ground, and the little ½ hp and 1 hp motors work about as well on the system in the steel mill as the big fellows. I have operated the electrical equipment in a steel mill for years with a solid grounded neutral with much better results than we were able to get without this grounded neutral. In fact, as the system was a three-wire dc system, 500 and 250 volts, it was almost impossible to operate without the ground connection. I have also operated 250 volt two-wire dc steel mill systems with grounded neutral connections, both with limiting resistance in ground connection and without it. I cannot say myself whether this limiting resistance should be used, but I do say make it very heavy,—that is allow at least 500 amperes to flow in it when a solid ground comes on one of the outside conductors, to take care of the motors usually used in steel mills on cranes and tables.

J. E. Fries in discussing this paper said in part:

"I think that there is no doubt that in an old mill where insulation commences to deteriorate the grounding of the neutral is the best way to cut down repair expenses. We can afford to put in balancer sets in many places rather than renew the transmission system. It is a question in my mind, however, whether a new mill, if you have a free hand in designing it, should be so laid out that you are in any way whatever dependent upon this safety measure."

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Moisture Content of Blast Furnace Coke

A Careful Study of the Methods of Correctly Determining the Amount of Moisture in Coke for Use in the Blast Furnace. Sampling Methods and Liabilities of Error.

By WILLIAM H. GEORGE.

DURING the war period the presence of widely varying and often excessive quantities of moisture in blast furnace coke prepared in the various types of by-product coke oven has frequently been a source of trouble to the metallurgist.

Variation.

The variation in moisture between such wide limits as 5 and 20 per cent, or even 25 per cent, in exceptional cases, is not conducive to the regular working of the blast furnace. It is common practice to charge a fixed weight of fuel, and to vary the burden according to the heat requirements of the furnace, the "available carbon" or calorific value of the coke being assumed to be practically constant. It is seldom, if ever, practicable to determine the percentage of moisture in each carload of coke used, and. moreover, the results obtained would only be of doubtful value, as the coke would probably before use be indiscriminately mixed in various coke bunkers according to the chance position of the trucks in the sidings. It is therefore clear that this variation, on account of the impracticability of determining its amount, introduces an additional element of uncertainty in blast furnace practice, and leads to waste of fuel. W. C. Gillhausen,* taking 1.263 tons of coke, containing 11.54 per cent ash and 11.72 per cent moisture, as necessary for the production, under ordinary conditions of working, of one ton of basic pig iron, finds that the extra consumption of coke per 100 tons of pig iron is 450 kilos. for every additional 1 per cent of moisture. A variation of about one-half cwt. (25 kilos.) of coke per ton of pig iron is sufficient to change the quality of the iron one grade.

Excessive Moisture.

The amount of moisture in the raw ores used is more or less beyond control, that in the fuel is not so. The oven coke production in 1918 (Eng.) was 13,301,548 tons. After deduction of 635,000 tons for export. and 20% for beehive oven coke, we have approximately 10,000,000 tons left for use in blast furnaces. Assuming a 10 per cent moisture content in this coke, 1,000,000 tons of water is needlessly carried about the country and introduced into blast furnaces.

Exhaustive investigations of the influence of moisture on the crushing strength of coke (see A. Wagener; Ferrum, 1913, 10, 321—336, 353—369) show that the strength of coke saturated with water up to 22.4 per cent is diminished by 14 per cent, as compared with dry coke. J. Boiteux (L'Echo de l'Industrie; Colliery Guardian, 92, 512) finds that with a coke containing 10 per cent of water the loss due to handling averages 5 per cent, and that such a coke will yield 8 to 10 per cent of coke dust.

Complaints of excessive moisture content by users of by-product oven coke are by no means novel. J. H. Darby in 1898 (J. Iron and Steel Inst., 53, 44) stated that he "has seen contracts for retort coke carried out where it was undertaken that the water and ash added together should not exceed 12 per cent, and where for months together no deducting was made for excessive percentage; 9—10 per cent of ash is a fair average for good coke, so very little room is left for water." He considered 2 per cent of moisture in retort coke "a fair allowance if the coke was carefully watered." In the discussion on the paper, C. Wood, presumably a user of the coke, said he found it to contain, generally speaking, from 12 to 15 per cent of moisture. "He had seen the coke arrive at the furnaces with the water actually dripping out of the bottom of the trucks. He had once dried nearly a whole truck, and found it threw off 17 per cent of water." This case may be taken as typical of the differences which occur between coke makers and coke users. In this particular case, makers and some users assert 2—3½ per cent of moisture, other users. 12—15 per cent. It is therefore clear that before complaints are made every possible care must be taken to insure that the results of analysis are not only accurate, but are representative.

Sampling.

By far the most fruitful source of error lies in the sampling, which is frequently left to persons who have no intrinsic interest in the work. The literature on the subject, in nearly every case, assumes that a sample has been obtained, and more careful consideration is given to such points as crushing, drying temperature, etc. The following appear to be the only two exceptions. A. Wagener recommends the taking of two forkfuls from the bottom of the car and one from the top, and one from the bottom and two from the top, of each alternate car, colored glasses being worn by the sampler so as to make all coke appear of uniform color, and to prevent the selection of pieces according to their good appearance or otherwise. The sample so obtained is crushed to egg-size, walnut-size, and pea-size, with careful mixing and quartering after each crushing. H. Brearley and F. Ibbotson ("Analysis of Steel Works Materials") recommend that at least 20 pieces be taken from each car, and that the sample be crushed on an iron plate to hazelnut size, and one-quarter of the bulk to pea-size, with careful mixing and quartering after each crushing. The final sample is crushed in an iron mortar to pass through a sieve of 60 meshes to the lineal inch.

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* See Wagener, Ferrum, 1913.

Communication to the Society of Chemical Industry, England.

The first method would not appear to be free from objection for general use, as the sample is selected from those portions of the cars which are usually the least representative. Coke at the top of the car on account of its exposure to the weather, suffers loss from evaporation, or gain from wetting by rain, while there is a tendency for breeze (the wettest portion of the coke) to collect at the bottom of the wagon during transit. In addition, the sample is selected from only three places in the car. The second method is not given in sufficient detail to be helpful.

It is doubtful if a representative sample can ever be obtained from the top only of a car. Where the car is unloaded from a side door by shovel, directly into barrows or skips, the sample is best obtained when the car is from one-third to one-half empty, when it will usually be found that the method of unloading exposes two complete sections from top to bottom of the car, on right and left of the door. It is necessary to make a mental estimate of the proportion of small and of large coke present and to try to preserve the same proportions in the sample. The author obtained and analyzed separately samples of the small and the large coke from a number of cars under the conditions previously given. In each case the sample of small was selected from that portion of the coke which would pass through a one-inch sieve. The sample of large was selected from the remainder of the coke. The first sample was well mixed, and 1,000 grms. was weighed in a porcelain dish, and dried at 150 degrees—200 degrees C. The second sample, after rapidly crushing to a similar size, was similarly treated. The results obtained and given in Table 1, show that the percentage of moisture in the small coke may be from 2 to 8 times that in the large. The small letters after the sample numbers refer to the brand of coke; the same letter is used for the same brand throughout the table:

Table 1.

Sample No.	A % moisture in large coke	B % moisture in small coke	Ratio B/A
1a	18.0	21.8	1.2
2b	9.3	13.4	1.4
3c	9.1	13.7	1.5
4a	14.6	21.8	1.5
5d	5.8	9.2	1.6
6c	11.8	19.1	1.6
7f	10.1	17.3	1.7
8g	12.3	21.3	1.7
9a	12.6	24.5	1.9
10c	5.8	11.4	2.0
11c	8.8	20.1	2.3
12h	4.6	12.0	2.6
14c	6.4	17.4	2.7
14a	7.1	19.8	2.8
15d	4.0	12.7	3.2
16d	3.6	12.6	3.5
17f	4.7	18.5	3.9
18i	4.3	18.0	4.2
19j	1.4	6.7	4.8
20g	1.6	12.0	7.5
21b	1.6	15.2	9.5

The distribution of moisture in the lumps was also examined as follows. During the unloading of a car a lump was obtained from the center. With chisel and hammer, portions about 1½ inches thick were rapidly chipped off the outside of the lump, and were at once placed in a dried and weighed glass jar fitted with a screw top. The remainder of the lump was then broken up, and portions from the center were similarly treated. The jars and their contents were then weighed and dried. Typical results, which are given in Table 2, show that the outer layer of a lump may contain 10 times as much water as the inner portion. The lumps were taken from different cars on different occasions, and in each of the cases 5—8 the whole of the outer portion and the whole of the inner portion of the lump were dried:

Table 2.

Sample No.	A. % moisture in outer 1½ in. layer of lump	B. % moisture in center of lump	Ratio A/B	Average % moisture in whole lump
1	3.4	0.3	11.3	—
2	10.0	1.0	10.0	—
3	19.3	2.5	7.7	—
4	28.2	4.2	6.7	—
5	7.1	1.38	5.1	4.6
6	15.0	4.25	3.5	11.4
7	10.5	5.0	2.1	9.7
8	18.6	9.4	2.0	18.5
9	24.0	12.7	1.9	—

Table 1 emphasizes the necessity of preserving in the sample the same proportion of large and small as in the car. Table 2 shows that care must be taken in selecting portions from lumps. Very considerable error would, for instance, be introduced by conscientiously chipping off small portions from a large number of lumps, in the hope of obtaining a representative sample.

It is well in sampling to take samples from points at regular distances apart, and it is helpful to place mentally some simple arrangement of straight lines over the section of coke, and to select pieces at each of the points of intersection of the lines. It would appear advisable, on account of the uncertainty of weather effects, to avoid sampling the coke at the top of the car to a depth of about one foot. This procedure, which by avoiding one portion of the wagon, will not give a strictly representative sample, is only fair if complaint of excessive moisture content is likely to be made. Care should also be taken to avoid sampling just after a fall of coke in the car. Lumps should be broken through the center before any portion is taken for the sample.

Weight of Sample

The weight of the original sample taken will depend on the amount of coke which it is taken to represent, and also on the degree of accuracy desired in the result. The most accurate result would, of course, be obtained by drying the whole car, a distinctly cumbersome procedure. When the sample has to be crushed by hand, the weight taken is often too small. For routine work a sample weighing about 14 pounds and consisting of about 20 lumps or portions will usually be found convenient and sufficiently accurate. We may adopt as a general principle that the addition or removal of the largest lump in the sample, no matter how wet or dry the lump may be, should not seriously affect the result. For example, let us suppose that from a car of coke containing 16 per cent of small, a sample weighing about 14 pounds has been obtained as described above. We may take it that each of the 20 portions will contain 300 grms. of dry coke, and that the sample will consist of three portions of small (average moisture content 16 per cent) and 17 portions of large (average moisture content 8 per cent). The average moisture of such a sample would be 9.296 per cent. If one lump of the large had been omitted, the average moisture content would be 9.363 per cent, while if one portion of small had been omitted, it would be 8.913 per cent. Further calculation shows that the average moisture content of the car of coke would be 9.28 per cent. It will be noted that the ratio of the percentage of moisture in the small coke, compared with that in the large coke, has, in this particular case, been taken as 2, but reference to Table 1, will show that it may reach as high a figure as 9.5. A few calculations similar to the foregoing, but with different numerical data, will show the impracticability of obtaining results, representative of the whole car, to 0.1 per cent. The author suggests that for routine work, results be reported to the nearest 1 per cent. This would be fully as accurate as the sampling would justify, and as would be of any service in works practice. If, in cases where the analysis of the same yields a result involving 0.5 per cent, the result be given to the nearest odd integer, the error due to the addition or subtraction of 0.5 per cent will, in dealing with a large number of samples, be minimized.

Crushing.

It is desirable that the sample be crushed as quickly as possible, in order to avoid appreciable error due to drying. A. Wagener found that saturated lump coke containing 16—20 per cent of water lost 4 per cent of water while being crushed and put through a sieve of 4 mm. meshes. Coke containing 9 per cent of water lost from 1 to 2 per cent under similar conditions. The weight of the sample should be reduced by quartering, and not by removing insufficiently crushed lumps by the use of a sieve. Before quartering, the well-mixed heap can be conveniently spread out by a spiral stirring motion of a brush handle. The only justification for the use of a sieve is to test the degree of fineness of the sample, but any advantage so obtained is more than counterbalanced by the disadvantage of the unavoidable extra drying which the sample undergoes during the sifting. In the preparation of a sample of very wet coke, on a day when the relative humidity is low, the error is considerable. There is a second objection to the use of a sieve by some samplers. Where the sampler's duty is to prepare, by hand crushing, an ultimate sample of about 300 grms. of 64-mesh coke, there is a tendency, at least on some occasions, for his conscience to be satisfied, if he merely crushes the coke for as short a time as will yield just about the desired 300 grms. and no more. Obviously the whole of the sample should be crushed to pass through the sieve. The author has found that in wet coke the portions of 64-mesh coke first obtained contain 2 per cent more moisture than the remainder of the sample, the wettest, and therefore the softest (and usually the outermost), portions of the lumps being of course the most easily broken. With further crushing this effect is lost, even before the greater part of the sample has been well crushed, as the smaller coke, offering a larger drying surface, loses moisture more quickly than the larger coke. In fact it will frequently be found that the 64-mesh coke is slightly drier than that remaining on the sieve, always provided that the sample, during preparation, has been spread out for a considerable time on the crushing plate. The ultimate degree of fineness of the sample, and the amount dried for the determination of water, will be fixed by similar considerations to those given in the previous paragraph. Previous to drying, if the sample be stored in a glass jar fitted with a tightly fitting screw-top or cork, there will be no important loss.

Determination of Moisture.

The determination of moisture in the prepared sample, involving as it does no chemical reactions, is by far the easiest portion of the work. Almost all textbooks give one method to be used for both coal and coke, thus neglecting the fact that coke is of much less delicate chemical constitution than coal. A method giving accurate results with coal will, of course, give accurate results with coke samples, but the restrictions of temperature, duration of heating, etc., necessary in dealing with coal, are quite unnecessary with coke. For coke samples, an American committee (Trans. Amer. Foundrymen's Association, 1912, XXI., 143) would restrict the drying temperature to 104 degrees—107 degrees C., Thörner (Stahl und Eisen, 1888, 8, 589) chooses 105 degrees—110 degrees C., while Brearley and Ibbotson choose 100 degrees—120 degrees C. Reference should be made to the work of A. C. Fieldner and W. A. Selvig (United States Bureau of Mines, Technical Paper 148), which deals with the determination of moisture in the prepared sample. Their conclusions, based on experimental evidence, may be briefly summarized here. Temperature, time, humidity of drying atmosphere, and fineness of sample may be varied over a considerable range without appreciably affecting the results. The maximum variation in the percentage of moisture produced by oven temperatures ranging from 105 degrees to 200 degrees C. was 0.3 per cent. Coke may be dried to "constant weight" without any gain in weight, due to oxidation taking place. Circulation in the oven of dried air, as is required for coal analysis, is unnecessary in dealing with coke. Moisture content can be quickly determined to within $\pm .05$ per cent by simply heating a large sample of lump coke at 100 degrees—200 degrees C. to constant weight.

Usually in works practice a fairly small sample (20—150 grms.) is dried by heating in a suitable oven. If advantage be taken of the fifth conclusion of Fieldner and Selvig, there will be much saving of labor and avoidance of congestion in the sample-house. The bucket, containing the lump sample, just as it has been obtained from the wagon, would be weighed and placed in a warm box or chamber, such as might be constructed on or by the side of the boilers of a blast furnace plant. The drying may be accelerated by passing air, conveniently obtained from the blowing engines and dried and warmed if convenient, through the chamber or even through the individual buckets if these are of suitable construction.

For special cases more accurate results will be obtained by passing dried air, nitrogen, or hydrogen over the gently heated coke and absorbing the moisture in a weighed drying tube. Graete (Braunkohle, 1906, 581—583) applied the method of distillation in dealing with brown coal and other fuels. Details of suitable apparatus will be found more recently. A weighed quantity of the coke is heated with petroleum spirit, and the distillation products are condensed in graduated apparatus, the water sinking to the lower graduated portion. Maurice (Comptes Rend. Mens. Soc. Ind. Min., 1899, 144—165) describes a rapid approximate method which he applied to washed coal to be used for coking purposes. A portion of the sample is shaken with twice its weight of calcium chloride solution (sp. gr. 1.4), the altered specific gravity of the solution after filtration is determined, and the percentage of moisture in the sample obtained by calculation, or by reference to tables.

Absorption of Moisture.

The maximum possible moisture content as indicated by the total amount of water which coke is capable of absorbing when immersed in water, varies with the porosity of the coke. G. D. Cochrane (J. Iron and Steel Inst., 1918, i., 146) gives the following figures: For hard coke 30.49 per cent (absorbed by dry coke), for soft coke 39.26 per cent, and for very soft coke 51.00 per cent.

Effect of Weather.

Calculation will frequently show that the effect of rain alone is insufficient to account for excessive moisture content. A wagon 17 feet long, 7½ feet wide, and 5¾ feet deep is designed to carry 12 tons of coke. The area of the top of such a wagon is 127.5 square feet, and the weight of one inch of rain over this area is 664 pounds. If we assume the 12 tons of coke to be dry, then the percentage of moisture in the coke, after one inch of rain has fallen on it, will be 2.4. There would be no experimental difficulties to hinder actual measurements of the weather effects, as wagons of coke can be weighed on an ordinary weigh-bridge to within 28 pounds, and records of the weather conditions are always available.

A. Hussener (J. Iron and Steel Inst., 1895, i., 329), in comparing two kinds of coke, mentions that Hussener coke containing 2.515 per cent of moisture was found to contain 4.5 per cent after two days of rainy weather, and that Otto-Hoffman coke containing 5.139 per cent was under the same conditions found to contain 9.5 per cent. The conditions are not, however, given in sufficient detail to enable the figures to be applied to other cases, and no other figures appear to exist in the literature of the subject.

In conclusion, the author wishes to thank The North Lincolnshire Iron Company, Ltd., for permission to publish the results.

Fire Clay Mixtures for High Temperatures

Harmful Results Which May Follow the Addition of Certain Foreign Materials to Ground Fire Clay and the Good Results Obtained by Adding Ground Bats.

By RAYMOND M. HOWE.

IN the making of so-called firebrick mortars it is common practice to add certain materials to the ground fireclay. At times these other materials are added by the manufacturers of the mortar, while at other time they are added by the mason entrusted with the laying of the brick.

Such materials are generally added to make the mortar set firmly without the application of heat, or to offset the natural shrinkage of the clay, or to cause it to burn to a dense structure by reason of decreased refractoriness.

Ground silica and alumina are often added, and since the clay itself is composed almost entirely of these materials, this practice is perfectly legitimate—in fact, the general properties of plastic clay can often be improved by making such additions. On the other hand, it is evident that the addition of certain other materials is not justified, and this paper is designed to show the effect of such additions.

In the experiments here reported, a very plastic fireclay was selected and different amounts of waterglass, salt, Portland cement, carborundum, asbestos and lime were added. The analysis of the original fireclay follows:

Analysis of Plastic Fireclay Used.

Ignition	11.12
Silica	56.42
Alumina	28.46
Ferric oxide	3.12
Lime	.52
Magnesia	.44
Alkalies	.24
Fusion point, Cone 30	100.32

After the various mixtures were compounded, small samples of each were fused in the usual type of furnace used in making such determinations. The results of this work are given in Tables 1, 2, 3, 4, 5 and 6, and are shown graphically in Fig. 1.

Paper read before meeting of Refractories Manufacturers Association and published by permission of the Director of the Mellon Institute of Industrial Research.

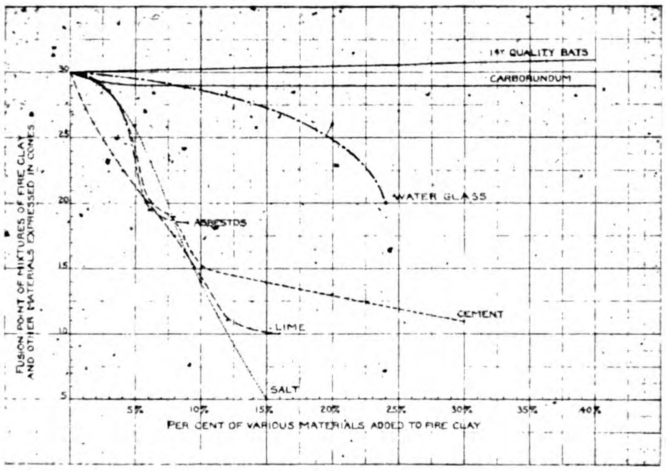

Fig. 1—Graphical results of tests showing the influence of the addition of Portland Cement, lime, asbestos, water-glass solution, salt and carborundum to fireclay.

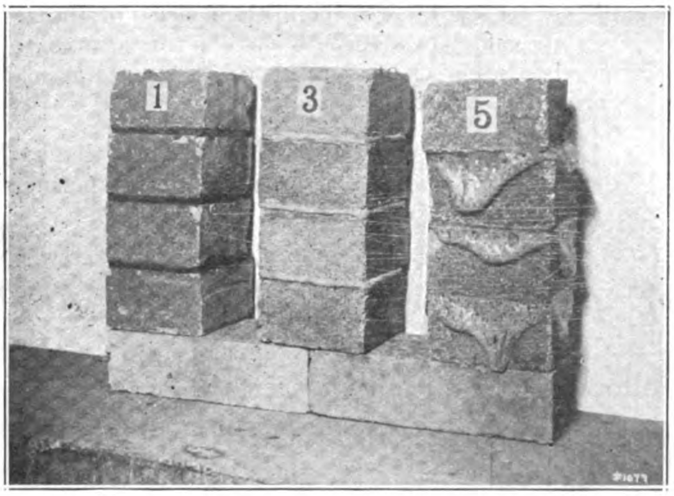

Fig. 2—The effect of heating on piers built up with mortar containing 10 per cent each of asbestos and water-glass. The column marked 1 is shown before being heated. Column 3 shows the effect of heating to 2012 degrees F., and column 5 shows the condition of the pier after being heated to 2,282 degrees F.

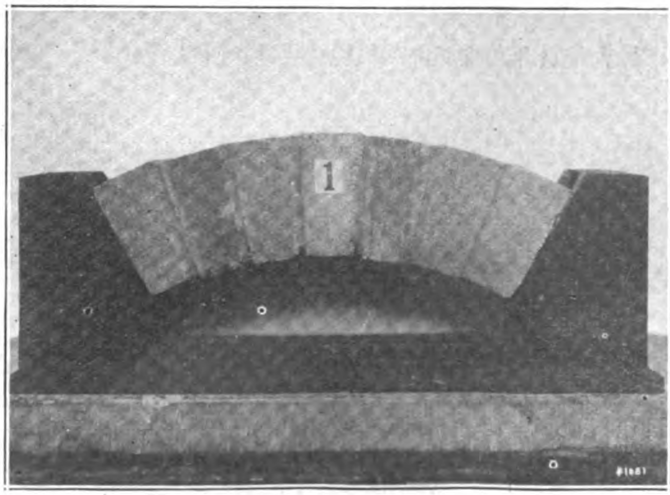

Fig. 3—Typical arch before being subjected to heat.

Table 1.
Influence of the Addition of Portland Cement to Fireclay.

Proportion	Fusion Point in Cones (Cone No.)	Fire Point in Degrees C.
100 per cent clay	30	1,730
96 per cent clay + 4 per cent cement	27	1,670
94 per cent clay + 6 per cent cement	20	1,530
92 per cent clay + 8 per cent cement	19	1,510
90 per cent clay + 10 per cent cement	15	1,430
80 per cent clay + 20 per cent cement	13	1,390
70 per cent clay + 30 per cent cement	11	1,350
60 per cent clay + 40 per cent cement	8	1,290

Table 2.
Influence of the Addition of Lime to Fireclay.

Proportion	Fusion Point in Cones (Cone No.)	Fusion Point in Degrees C.
100 per cent clay	30	1 730
96 per cent clay + 4 per cent lime	20–26	1,590
92 per cent clay + 8 per cent lime	17–18	1,480
88 per cent clay + 12 per cent lime	11	1,350
84 per cent clay + 16 per cent lime	10	1,330

Table 3.
Influence of the Addition of Asbestos to Fireclay.

Proportion	Fusion Point in Cones (Cone No.)	Fusion Point in Degrees C.
100 per cent clay	30	1,730
97 per cent clay + 3 per cent asbestos	28–29	1,700
94 per cent clay + 6 per cent asbestos	19–20	1,520
91 per cent clay + 9 per cent asbestos	18-19	1,500

Table 4.
Influence of the Addition of Water Glass Solution to Fireclay.

Proportion	Fusion Point in Cones (Cone No.)	Fusion Point in Degrees C.
100% clay	30	1,730
96% clay + 4% water glass	29–30	1,720
92% clay + 8% water glass	29	1,710
88% clay + 12% water glass	28–29	1,700
84% clay + 16% water glass	26–27	1,660
80% clay + 20% water glass	26	1,650
76% clay + 24% water glass	20	1,530

Table 5.
Influence of the Addition of Salt to Fireclay.

Proportion	Fusion Point in Cones (Cone No.)	Fusion Point in Degrees C.
100% clay	30	1 730
95% clay + 5% salt	26	1,650
90% clay + 10% salt	14	1,410
85% clay + 15% salt	5	1,230

Table 6.
Influence of the Addition of Carborundum to Fireclay.

Proportion	Fusion Point in Cones (Cone No.)	Fusion Point in Degrees C.
100% clay	30	1,730
95% + 5% Carborundum	29	1,710
90% + 10% Carborundum	29	1,710
85% + 15% Carborundum	29	1,710
80% + 20% Carborundum	29	1,710
70% + 30% Carborundum	29	1,710
60% + 40% Carborundum	29	1.710
50% + 50% Carborundum	29	1,710

A careful examination of these data shows very clearly how seriously the addition of lime, Portland cement, asbestos and salt affect the quality of fireclay, the addition of only 5 per cent of these materials lowering the fusion point about 200 degrees F. Water-glass and carborundum did not exert so marked an influence.

The combined effect of the addition of asbestos and water-glass to fireclay may be appreciated more fully if a mortar of the following composition (Mortar No. 1) be studied. The chemical analysis indicates that about 10 per cent of each of these materials was added to fireclay or silica cement in making the mortar.

Analysis of Mortar No. 1.

Ignition	8.94
Silica	72.96
Alumina	7.64
Ferric oxide	1.11
Lime	.34
Magnesia	3.01
Alkalies	6.76
Fusion point, below Cone 11	100.81

Piers were built in which this mortar was used in making the joints and after being dried they were placed under a pressure of 11 pounds per square inch and heated.

Fig. 2 depicts the effect of such treatment, the column marked 1 showing a pier before being heated. The column marked 3 shows the effect of heating to 1,100 degrees C. (2012 degrees F.) and the column marked 5 the condition of a pier after being heated to 1,250 degrees C. (2,282 degrees F.)

Arches were then constructed, using the same mortar in the joints. Fig. 3 shows a typical arch before being heated, while Fig. 4 shows a similar arch after it had been heated to 1,250 degrees C. (2,282 degrees F.)

These tests convinced the writer that although the addition of these materials improved the working and setting properties of the mortar, mortars so made should not be used at high temperatures. If they are used, the foreign ingredients should be used in very small amounts. However, it must be a fact that fireclay, when used alone, does not give a satisfactory joint for some purposes—otherwise no attempt would be made to improve it.

Much of the dissatisfaction which has attended the use of fireclay to which no foreign material had been added can be traced to the shrinkage of the fireclay during the application of heat, for if this tendency to shrink could be overcome, the joints would be firmer, tighter and would not fall out of the arches.

A logical way to prevent this shrinkage and so establish a firmer joint is not to add foreign materials to the fireclay, but to use the same material, taking the precaution however, to add a certain amount of clay which had previously been shrunk.

To demonstrate this, some bats of first quality brick were finely ground and mixed with the same fireclay as was used in the other experiments. The effect of this addition upon the fusion point of the clay is shown in Table 7 and is decidedly favorable.

Table 7.
Influence of the Addition of Ground First Quality Bats to Fireclay.

Proportion	Fusion Point in Cones (Cone No.)	Fusion Point in Degrees C.
100% clay	30	1,730
75% clay + 25% bats	30–31	1,740
50% clay + 50% bats	31	1,750
25% clay + 75% bats	31–32	1,760

The effect upon the shrinkage is shown in Fig. 7, where mixture 1 is 25 per cent plastic clay and 75 per cent ground bats, mixture 2, equal quantities

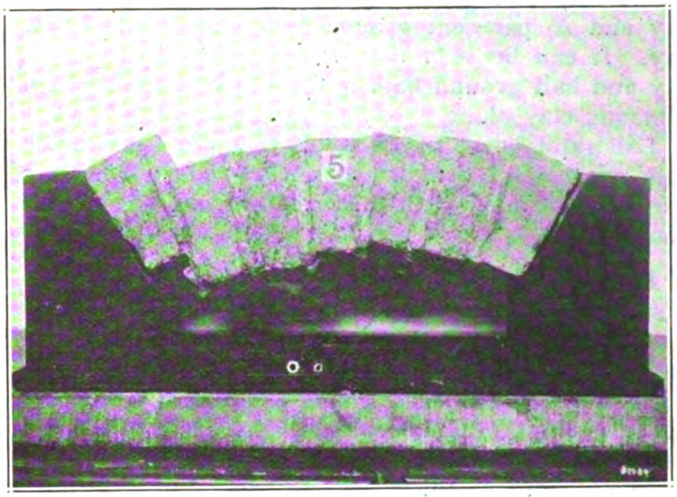

Fig. 4—Same arch as in Fig. 3 after being subjected to a temperature of 2,282 degrees F.

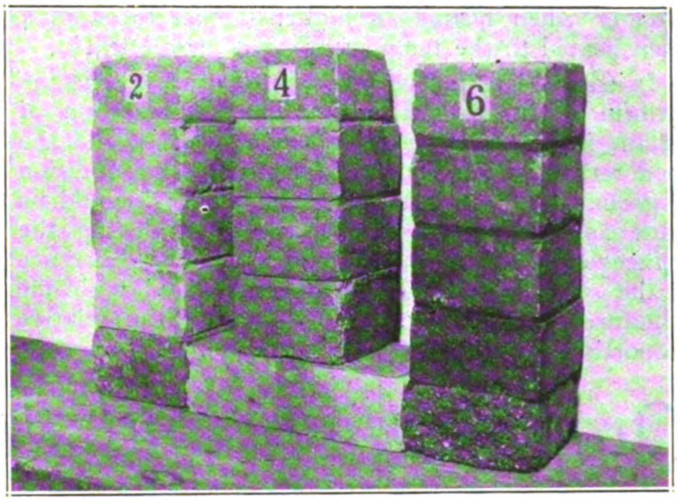

Fig. 5—Mixture composed of equal quantity of ground bats and plastic clay subjected to heat. The column marked 2 was not heated; 4 was heated to 2,282 degrees F.; 6 was heated to 2,462 degrees F.

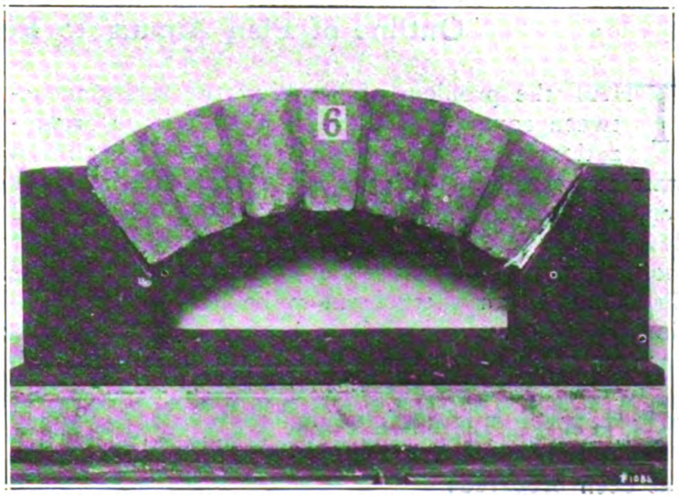

Fig. 6—Same mixture as is shown in Fig. 5, subjected to arch test. These joints are firm and strong after having been subjected to 2,462 degrees F.

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plastic clay and ground bats; 3, 75 per cent plastic clay and 25 per cent ground bats and 4, all plastic clay. It can be seen that 2, containing half plastic clay and half ground bats is far superior to 4, which is plastic clay alone.

Laboratory tests also showed that the joints made from the mixture of half ground bats and half plastic clay were stronger than those made from plastic clay alone.

Before passing final judgment upon the merits of such a mixture, however, it was decided to subject it to the same tests as were applied to Mortar No. 1 and Fig. 5 shows the results of the column tests, 2 not having been heated, 4 having been heated to 1,250 degrees C. (2,282 degrees F.) and 6 to 1,350 degrees C. (2,462 degrees F.)

The results of the arch tests are shown in Fig. 6, this arch having been heated to 1,350 degrees C. (2,462 degrees F.) It will be noted that these joints are firm and strong and that they have not begun to soften. As a matter of fact, such joints are stronger when heated to higher temperatures than when heated to the temperature just mentioned.

In conclusion, the writer wishes to emphasize the harmful results which may follow the addition of certain foreign materials to ground fireclay and the good results which may be obtained by the addition of ground bats. In either case, the joints should be made as thin as possible, not only to lesson the chances of harmful results arising from the difference in the structure of the joint as compared with the structure of the brick, but to increase the relative proportion of brick to joint for at no time can the joint be expected to exert a greater resistance to the action of destroying influences than can the brick itself, particularly if the brick has been selected with a view to resisting conditions such as the finished work will meet.

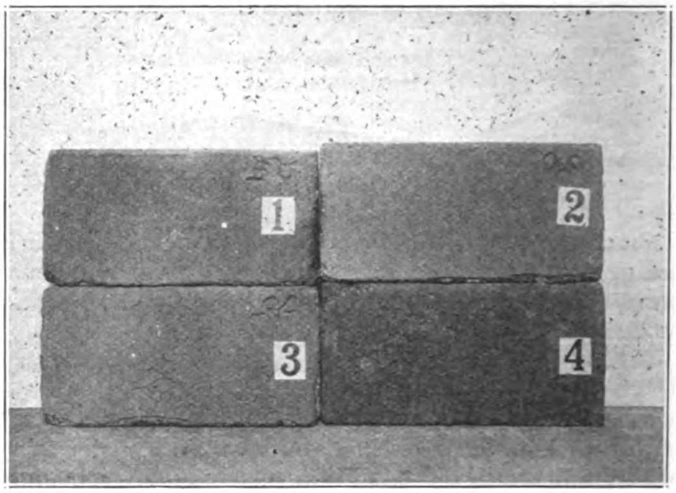


Fig. 7—In order to demonstrate the shrinkage of various fireclays some bats of first quality brick were finely ground and mixed with the same fireclay as in the other experiments. The effect of shrinkage is shown in this illustration. The mixture marked 1 is 25 per cent plastic clay and 75 per cent ground bats; mixture 2, equal quantities plastic clay and ground bats; mixture 3, 75 per cent plastic clay, 25 per cent ground bats; mixture 4, all plastic clay. The illustration shows that the mixture containing half plastic clay and half ground bats is far superior to the mixture containing plastic clay alone.

Organization and Functions of a Modern Industrial Relations Department

Outline of Plan Aiming to Reduce Loss in Working Time, and Labor Turnover—Elimination of Labor Disputes—Improving Outline of Plan Aiming to Reduce Loss in Working Time and

THAT the problem of handling the relations between company and employe in a large organization requires a specially trained and organized staff is now universally conceded, but inasmuch as very few employers have taken up this subject and developed it in any well planned or scientific way, one looking to find a correct criterion to follow will be disappointed, for there seem to be no two organizations developed along uniform methods. For the guidance of those who are interested in practical research as to the best methods of organization and the apportioning of specific functions to highly developed sub-divisions of a general plan the following outline has been prepared:

It is not claimed that this outline is ideal, but it has been drawn up after extensive study of the most successful employment and welfare organizations of the present day.

The handling of employe relation problems should be the function of a special department which should come directly under the president or the general head of the company, and this department should be managed by a special official who reports directly to the president.

The functions of a modern industrial relations are:

1. To engage, place, transfer and remove workmen.
2. To provide for the safety of employes.
3. To provide for the good health of employes.
4. To provide for the mental, physical and social welfare of employes.
5. To provide health, accident, death, and old age insurance.

Each of these five divisions requires the supervision of an experienced executive who has the technical education and practical experience coupled with a pleasing personality to put it across. These five division heads should meet regularly in joint conference with the director of the department, and should also meet in regular conference at the meetings of the heads of all the other departments of the plant, in order that thorough understanding and coöperation maybe had from all sides.

Each of the five main divisions should be again divided into clearly defined units in order that no phase of the work will be neglected or favored. A tentative outline of the sub-divisions follows:

1. A—Employment.
1—Employment office.
Engages new employes.
Rehires and transfers old employes.
Studies the jobs in the plant and working conditions so as to intelligently place employes.
2—Registration Office.
Makes up the employment records of all employes engaged.
Assigns check numbers and clock cards to new employes.
B—Bureau of Labor.
1—Labor clerks to keep daily records of the work and progress of employes in the various departments.
2—Investigation of absentees at their homes to find out the reason for absence, and to offer help in case of sickness or death.
3—Interviewing of all quitters and other employes who may be disgruntled or have labor troubles or complaints, and to adjust same whenever possible, and to pass on all discharges with final authority.

2. Safety Department.
1—To provide safe working conditions.
2—To teach and train men to follow safe methods of work.
3—To investigate accidents and remove the cause whenever possible.
4—To provide for policing the plant.
5—To provide fire protection for the plant.
6—To provide wash and change houses, lockers, etc., and care for their upkeep.

3. Medical Department.
1—First-aid equipment and care of injured and sick.
2—Physical examination of new employes.
3—Follow up of sick and injured employes.
4—Visiting nurses to give aid in the homes of the sick and injured.
5—Dental clinic service for employes.
6—To see that pure water is provided, and that good sanitation is maintained in the shop and plant.
7—To instruct employes in personal hygiene.

4. Welfare Department.
A—Education.
1—To provide schooling for aliens.
2—To provide technical courses of instruction to train employes for better positions.
3—To provide a library for employes.
4—To publish a factory newspaper, the aim of which is to develop an esprite d' corps, and to stimulate employes to develop themselves along the right lines.
5—Suggestion committee to stimulate the giving of suggestions by employes and reward for same.
B—Recreation.
1—To organize sports and athletics for recreational purposes and to develop a factory spirit.
2—To provide and maintain playgrounds where employes live in large neighborhoods.
3—To organize and develop social amusements such as dances, corn roasts, picnics, field days, etc., for the benefit of the employes and their friends.
C—Welfare.
1—To help the employe solve his domestic and other personal troubles.
2—To teach housekeeping and home hygiene in the homes of employes.
3—To follow up the work of community agencies in order to protect the health, welfare and other interests of employes and their families.
4—To give free legal aid and advice to employes and to help employes to get out of debt by securing the coöperation of creditors in preventing attachments and the pooling of payments, etc.
5—To aid aliens in raising their standards and methods of living; to advise and help them in securing citizenship papers and to aid in their Americanization.
6—To operate a housing bureau to secure houses and rooms for employes, and where company has houses to rent to supervise their renting; to work for civic improvement and betterment of housing conditions. Where company has labor camps to supervise and look after same.
D—Coöperative Stores.
To organize and operate a coöperative store for the benefit of employes.

5. A—Accident Insurance.
Claim department to handle accident cases and take care of state compensation for same.
B—Insurance Benefits.
Sickness and death benefits organized under one of the three following plans:
1—Supported entirely by the company.
2—Supported jointly by the company and employe.
3—Supported entirely by employe.
C—Old Age and Service Pensions.
Provide retirement pensions to employes for long and faithful service.

The work of all the departments should be made a matter of complete record, and to facilitate in doing this a statistical department should be operated as a binder. This department would take care of all the reports and statistical records of all the departments, and a central filing system should be used for keeping records of employes. A tabulating machine could be used to great advantage in preparing detailed reports of the work and progress of the various branches of the work. Without adequate analytical records of the work done and results obtained, much time and money could easily be wasted on useless enterprises. Unless the services rendered to employes develop a loyal, contented working force and furnish proper incentives to stimulate wholehearted coöperation from the employe, they are wasted.

Research Stimulates Heat Treating Methods

A Review of the Technical Advances Made During the Past Year in Heat Treating Methods—Work of Societies—Several Important Patents—Many New Laboratories.

By D. W. McDOWELL.

THE closing of hostilities in November, 1918, left the steel manufacturer in a position which he found to be the reverse of that which he had been accustomed during the previous years. He had been hard pressed for tonnage during the war and that thought was the dominant feature of practically all his transactions during that trying period. The consumer was compelled to accept such material as he could get without special reference or attention to the quality of goods he was using. Furthermore, the consumer was compelled to pay a very high price for this material, consequently when the war closed he demanded quality in accordance with the price he was compelled to pay and the manufacturer, as previously stated, found a condition in which quality and not quantity was the predominant demand.

In order to meet this demand, the manufacturer had been compelled to resort to every known improvement in heat treating and, in many instances, to improve upon previous methods. This fact is one of the most important reasons why heat treating has advanced with astounding rapidity, coupled, of course, with the natural thirst of man for knowledge.

In reviewing some of these advances we might mention the following patents issued during the past year:

Patent No. 1,290,384, issued to Alfred Smallwood, of London, England, comprises certain improvements relating to furnaces for heat-treating metals. The object is to provide means whereby the work to be treated may be transferred to the quenching bath without being exposed to the air.

Patent No. 1,290,561, issued to C. J. Jackson and R. S. Squire, relates to a machine for hardening hacksaw blades. The operation is continuous and automatic, the blades being fed into the heating chamber and from there carried into the quenching bath without access to air or requiring additional handling.

Patent No. 1,310,020, issued to Charles A. Huestin, relates to methods of hardening high-speed steel, quenching in mixture of soap, salt, and kerosene.

Patent No. 1,309,137, issued to A. G. E. Hultgren, relating to a method of hardening whereby uneven cooling was partly eliminated. The process consists of causing the body to be hardened to rotate before and while being immersed in the quenching medium.

These are a few of the patent which have been issued in connection withs heat-treating during the year 1919.

Further evidence of the importance of heat-treatment will be realized when we consider the large number of laboratories that have been erected and equipped throughout the country by steel mills and also the number of independent laboratories doing research work of all kinds of which investigations of the effect of heat upon steel is not a small part of the work.

The pyrometer manufacturer has succeeded in making instruments which are fool-proof and which will register correctly to narrow limits at hight temperatures. This in itself is an achievement worthy of comment, but when we consider that the practical man admits the pyrometer is a better guide than the eye, then we have an advancement which goes far to increase quality and production, and this is becoming a daily occurrence.

The manufacturer of furnaces for heat-treating have succeeded in constructing furnaces which will maintain constant temperature throughout and we have furnaces on the market today which will not vary five degrees Fahrenheit from end to end.

New carburizing compounds have been put on the market and many new facts in case carburizing have been established and made universal practice.

Scientific apparatus used in metallurgical laboratories has been perfected to a high degree of accuracy and daily advances are being made in this important branch of heat-treatment.

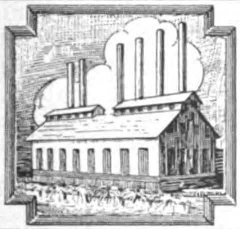
The establishment of new societies and the expansion of an older one has done much to stimulate interest in heat-treating.

During the past year the Steel Treating Research Society has established chapters in Cleveland and Pittsburgh, and the American Steel Treaters' Society has established chapters in Cleveland, Pittsburgh, Philadelphia, New York City, Rochester, Buffalo, Cincinnati, Milwaukee, Minneapolis, Moline and St. Louis.

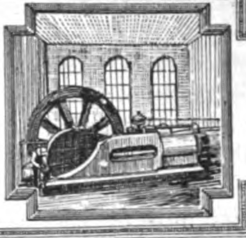
These societies are doing much to advance the art of heat-treating. They issue monthly journals in which are published the papers read at the monthly meetings of the various chapters, also other items of interest to steel treaters and manufacturers of iron and steel.

During September, of 1919, the first exhibition of steel treated articles and appliances was held in Chicago under the auspices of the American Steel Treaters' Society and it has been planned to make this an annual occurrence.

These are a few of the advances which have been made during the past year and in view of the vast field afforded for research and investigation in this particular subject, we have reasons to believe that future years will bring forth still greater development in this particular branch of the industry.



STEAM POWER DEPARTMENT



Speed and Power of Curtis Steam Turbine

Considerations Regarding the Design of Single Shaft Curtis Steam Turbines Showing that Under Stated Conditions a Turbine Can Have Its Most Economical Point at 21,000 KW.

By **ESKIL BERG.**

THE purpose of this paper is to discuss the limitations of the types of turbines used in the more important work now done by the General Electric Company, and to show the relative results which can be accomplished with such designs under different conditions of load. Different mechanical arrangements will make practicable different characteristics, and the conditions shown only apply to machines of these particular designs. The design of turbines must be governed by many compromises and it would not be possible to give a correct idea as to the whole range of possibilities.

For purposes of illustration, two machines have been selected, one representative of the largest size built for 1,800 revolutions per minute, and one of the largest size now built for 3,600 revolutions per minute.

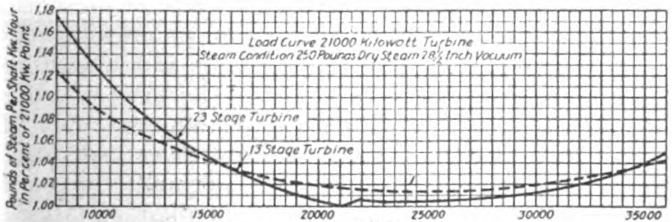


Fig. 1.

The figures given relate to the turbine alone, and do not include generators. The generators used with such turbines might be designed for various power factors or overload capacities, and would thus be of different efficiencies.

The turbines in question are both of the single-flow type and may be considered representative of capacity limitations of that type, since their construction is that which is adapted to the highest capacity. The single-unit turbine and generator is naturally preferable over the tandem and compound type on account of simplicity, lightness, and efficiency. There are however certain definite limitations in the size for a given speed that these units can be built with material available at the present time. The limitation in the size of a unit for a given speed does not depend upon the generator, but is entirely dependent upon the turbine.

Fig. 1 shows the load curve of the large 1,800 revolutions per minute machine above mentioned, which is designed to operate with 250 pounds steam pressure, 28.5 inches of vacuum, and dry steam. This turbine has 23 stages, all wheels being of the single-bucket type. The first stage wheel has a pitch diameter of 35 inches, which increases with each successive stage until the last wheel, which has a pitch diameter of 88 inches. This curve shows that for 1,800 revolutions per minute, a turbine can be designed for a vacuum of 28.5 inches, giving its best efficiency at 21,000 kw., this point being marked on the curve by 1, and the water rate at other points being given in proportion to this point. This curve also shows that with a sacrifice of 5 per cent in efficiency, an output of 36,000 kw. can be delivered to the turbine shaft. Above a load of 21,000 kw. live steam is bypassed to the eighth stage shell, the effect of which is shown by the break in the curve.

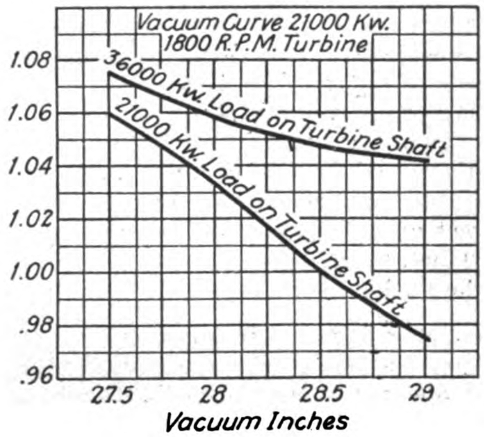


Fig. 2.

Paper read before Three-hundred and Fifty-fifth meeting of A. I. E. E., New York, November, 1919.

The dotted line gives the load curve of a similar turbine in which the first 11 stages are replaced by one two-bucket stage. This turbine is designed with multiple valve steam admission. Such a modification may be desirable for the purpose of simplification, or where better efficiency at very light loads is important, as in the case of propulsion of warships.

Fig. 2 gives the vacuum curve of the 1,800 revolutions per minute, 23-stage machine at 21,000 kw and 36,000 kw load on the turbine shaft. It will be noticed that the improvement in economy at a load of 21,000 kw, is 2.5 per cent between 28.5 and 29 inches, whereas with a load of 36,000 kw, due to congestion of the steam passages, the gain is only 0.55 per cent.

Many large size turbines are now designed for a vacuum of 29 inches. The volume of one pound of steam at this vacuum is 652 cubic feet, almost 50 per cent greater than at 28.5 inches, and about twice as much as at 28 inches, which calls for a corresponding increase in the area of the steam passage in the last stage wheel. If this area is made too small, the steam when leaving the last row of buckets must have a high velocity, which gives a large loss of energy, this loss being in proportion to the square of the velocity. It is therefore important that this area be made as large as possible, and that the exit angle of the blades be made small enough to give good extraction.

Efficient action can only be accomplished by using a bucket speed that bears a proper relation to the steam velocity. Consequently to get the largest capacity we must not only use long buckets, but must move them at a very high speed. In order to obtain good bucket action, the buckets should not be more than about one-fourth as long as the pitch diameter of the wheel. If they are made longer than this, poor bucket action with consequent loss in efficiency will result, due to the great difference in peripheral speed between the base and the tip of the bucket, the design being made correct for the middle point or pitch line. The flare also becomes excessive, so that the space between the buckets at the tip will be so large that steam can flow between the buckets without doing any work.

The use of a high steam speed in this last stage naturally implies that a relatively large proportion of the total steam energy must be utilized there, and such concentration of work into a single stage is not without its disadvantages, since even if the best relation of velocities is maintained, such a stage doing a large amount of work is naturally less efficient than a stage of similar character doing less work.

Since for the reasons given above, the design of the last stage in such a turbine constitutes the most important limitations, we will consider some details of the design used in this case. Fig. 3 represents the last wheel of the large 23-stage 1,800 revolutions per minute turbine which has been mentioned. This turbine is designed to operate at 250 pounds steam pressure, 28.5 inch vacuum, and dry steam. The pitch diameter of the wheel is 88 inches, length of buckets 22 inches, and bucket angles 60 degrees entrance and 40 degrees exit. The wheel is subject to the following stresses at normal speed:

Stresses in hub, 23,450 pounds per sq. in.
Stresses in web, 22,950 pounds per sq. in.
Stresses in bucket, 20,100 pounds per sq in.

Elastic limit, (limit of proportionality) of material, 55,000 pounds per square inch. The material of the wheel and bucket is quenched and tempered 3 per cent nickel steel.

The wheel is stiff enough to avoid vibration effects, and in the absence of such effects the centrifugal strains afford ample factors of safety, even if we assume considerable irregularities and imperfections of metal structure.

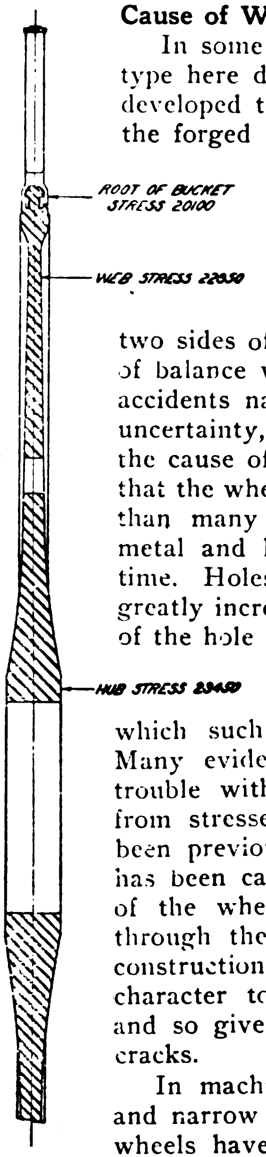


Fig. 3.

Cause of Wheel Breakages.

In some of the first large machines of the type here discussed, very serious trouble has developed through the formation of cracks in the forged wheels. Such cracks have caused wheels to break in three important installations. The cracks which have formed in these wheels have started at holes in the wheel provided either for balancing steam pressures on the two sides of the wheel, or for the attachment of balance weights. The occurrence of these accidents naturally gave rise to much alarm, uncertainty, and difference of opinion as to the cause of the trouble. Calculation showed that the wheels which broke were less stressed than many which were made from weaker metal and had operated for long periods of time. Holes in a centrifugally stressed wheel greatly increase the fiber stress in the vicinity of the hole itself, but such conditions had not caused the formation of cracks in large numbers of wheels in which such localized high stresses existed. Many evidences have now shown that the trouble with these wheels has not resulted from stresses in excess of those which had been previously found to be practicable, but has been caused by fluttering and vibrations of the wheels, which had become possible through the lightness and thinness of their construction. Such vibration gives a periodic character to the stresses normally imposed and so give rise to the formation of fatigue cracks.

In machines of this type relatively light and narrow buckets have been used, and the wheels have been proportioned with a view to ample centrifugal strength, but with maximum economy of space and weight, consequently these wheels have had much less lateral stiffness than wheels used in turbines of previous types. To overcome such troubles as have developed, it is simply necessary to make the wheels stiffer and to put in holes in part of the wheel near the hub where a suitable reinforcement of thickness can be provided which both stiffens the wheel and reduces stresses near the holes. Very slight changes of this kind make a great difference in the vibrating characteristics of such wheels, and the proportions used are such that they can easily be brought to the same standards of safety in these respects as have long prevailed in wheels of heavier construction in machines having less numbers of stages.

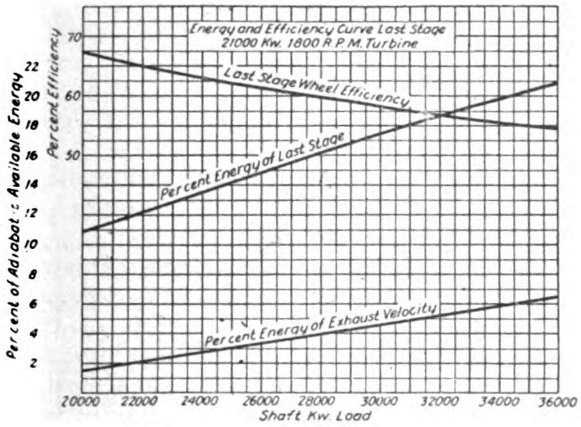


Fig. 4.

Fig. 4 gives the energy and efficiency curves of this last stage. It will be noticed that at the most efficient point, (21,000 kw), this stage absorbs 11.5 per cent of the total adiabatic available energy, and that the wheel efficiency is 66.25 per cent. The energy represented by the exhaust velocity which is all wasted in the condenser is 1.5 per cent of the total energy. As the load increases on the turbine shaft, the energy in this stage also increases, decreasing its efficiency until at 36,000 kw the energy in the last stage is 20.9 per cent of the total energy. The wheel efficiency however has been reduced to 54.2 per cent and the energy represented by the exhaust velocity has been increased to 6.4 per cent. This great amount of work in the last stage at such poor efficiency naturally lowers the efficiency of the whole turbine, and in this case the efficiency at 36,000 kw is 5 per cent lower than at 21,000 kw.

Fig. 5 shows leakage and rotation losses of the same turbine in per cent of input.

From the above it will be seen that for 1,800 revolutions per minute, a turbine can be designed efficiently for 21,000 kw which, with a sacrifice of efficiency can deliver 36,000 kw.

Fig. 6 gives a load curve of the smaller 3,600 revolutions per minute turbine. The water rates are here given in reference to that of the larger machine, the load of 5 000 kw corresponding to that of 20,000 kw on the 1,800 revolutions per minute turbine. This turbine has only five stages, one two-bucket wheel in the first stage, the other four stages having single-bucket wheels. The first wheel has a pitch diameter of 35.5 inches, and the remaining four wheels a pitch diameter of 51 inches. The bucket height of the last wheel is 9.125 inches, the turbine being designed for a maximum of 6,250 kw.

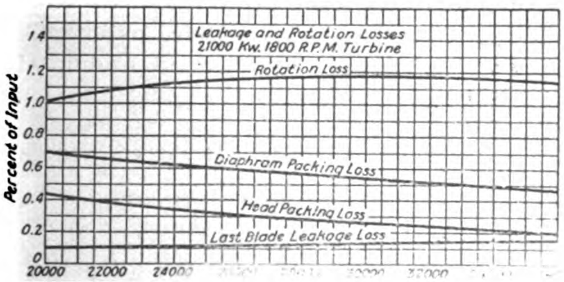


Fig. 5

The reason for such a discrepancy in the number of stages calls for explanation. As the output of a turbine, keeping approximately the same stresses, goes up inversely as the square of the revolution per minute, if the same number of stages could be used and clearance and all dimensions proportionately reduced, a 5,000 kw machine at 3,600 revolutions per minute could be made nearly as efficient as a 20,000 kw machine at 1,800 revolutions per minute, and developments of smaller multi-stage machines at our Lynn Works have already been made which approximate such possibilities. Constructions however which are practicable on a large scale are not practicable on a small scale, and consequently there are difficulties in getting the space economy in small high-speed machines which would be necessary for accomplishing the result stated. One of the difficulties has lain in the construction of diaphragms, the casting in of nozzle partitions being easy in a large diaphragm and very difficult on a small one. We are working upon types of diaphragms and other parts which may make possible the development of multi-stage high speed machines which afford improved degrees of economy.

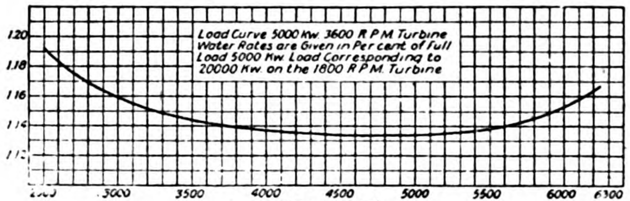


Fig. 6.

If a 10,000 kw turbine is designed for 1,800 revolutions per minute, the only change necessary would be to make the nozzle and bucket heights about half the height of those in the 20,000 kw unit. This reduction in height of buckets and nozzles would affect the weight, size, and cost of the turbine very little as compared with the 20,000 kw unit. In regard to economy, the lower bucket heights would reduce the rotation loss somewhat, but far from 50 per cent. The diaphragm packing loss, head packing losses, and bearing losses would be practically the same as on the 20,000 kw unit, so that while a turbine designed for 10,000 kw would be more economical than the large turbine running at half load, the difference would be small, being only about 6 per cent.

It will be seen from this paper that for a given speed there is one particular size of turbine which can be designed to be most economical as to steam consumption, weight, space, and price per kilowatt. Even if a size smaller than this is required, it would in many instances pay for the central station to install the larger unit, even though it would have to run at reduced load for some time before the station load increased sufficiently to utilize the full capacity.

The Fuel Situation – Past and Present

In Which the Author Reviews the Past Conditions, Present Demand With Special Reference to Coal, Oil and Gas—Need for Conservation of Fuels Among Industrial Plants Imperative.

By CHARLES LONGENECKER.

From an industrial point of view the history of the year 1919 reveals very little of a constructive nature. In fact, in most instances, it was the reverse. That this should be the case is only natural, for while the armistice was signed in 1918 the ill effects of the war lasted through 1919, and in a large measure determined the history of that year.

The demand for fuel under these unfavorable conditions would naturally be below normal but there were other factors which both directly and indirectly added strength.

These were: The necessity to replenish the depleted fuel reserves in foreign countries.

The manufacture and transportation of commodities, other than fuels, needed to restock the exhausted stores both abroad and at home.

The domestic fuel market was sustained also by flourishing conditions in the automobile and harvester trades. There was likewise a heavy demand for pipe from the newly opened oil districts. It was the orders from these branches of industry, which, in a large degree, kept the steel mills in operation and thereby indirectly created an additional demand.

Not only are the materials of war derived largely from our oil and coal, but the pursuits of peace time as well, require supplies originating in these minerals. Knowing then that our progress is so intimately related to the cost and supply of these fuels, we can with interest, note the development made in the past and mark the trend towards greater efficiency in production and utilization.

Coal.

The principal source of heat and power in the United States, is coal. Fuel oil occupies a secondary position and this is followed in turn by natural gas.

It is estimated that 52 per cent of the coal supply of the world is to be found within the borders of this country. In this estimate is included both anthracite and bituminous coal as well as lignite and peat.

The output of coal in 1919 is approximately as follows:

	Net tons
Bituminous coal	458.063 000
Anthracite	86,200 000
Total	544,263,000

This production is smaller by about 150,000,000 tons than that of 1918. The cause of this decrease can be attributed to the shortage of cars and labor and to the strike of the bituminous miners in November and December.

Very few appreciate the immensity of our lignite deposits which are to be found in the states of North and South Dakota and Northeastern Montana. These total 964,000,000,000 tons. The quantity mined amounts to about 650,000 tons a year.

There has been very material progress in late years directed towards a greater conservation of our coking coals. In November, 1918, the output of the by-product ovens exceeded in tonnage that produced in the bee-hive type. Undoubtedly, henceforth the difference in production will grow rapidly in favor of the by-product type.

Petroleum.

The year 1919 was unquestionably the most spectacular in the entire history of the petroleum industry. There was a record breaking production which will probably reach 375,000,000 barrels. The production in 1918, which exceeded all records up to that time, was 345,500,000 barrels. The greatest increase was from the fields in Louisiana, Texas and California, where at times the flow of oil was so great that it was impossible to construct pipe lines adequate to carry it. The consumption of fuel oil kept pace with the production so that there was not a very marked decrease in price. The importation of oil from Mexico caused a reduction along the Atlantic Coast, but this was confined to those districts accessible to the large oil carrying vessels. Pennsylvania crude sold at $5 per barrel in December and other grades advanced in proportion.

It is of interest to compare the depth and flow of the wells of the present with the first one drilled by Drake in 1859. This well was 70 feet in depth and produced 20 barrels of oil per day. A well in the Burk-Burnett field of Texas, will average 3,300 feet in depth and it is not uncommon to secure a flow of 1,500 barrels every 24 hours. Wells for oil and gas have been sunk to a distance of over 7,000 feet.

For fuel purposes the crude oil is used either as it comes from the well or the light gases are first extracted. By extracting the gasoline, naphthas and kerosene, the "flash point" is reduced to a point where it will meet rigid specifications. From the known fields of today it is estimated that 42 barrels per capita have been used and that 70 barrels per capita remain for future use.

Natural Gas.

Since 1874 natural gas has been the dominant fuel in the metallurgical furnaces of Western Pennsylvania, Ohio and West Virginia. The supply of this fuel, especially during the winter months, has become very uncertain and at times it has been necessary to curtail the supply for industrial purposes in order to meet domestic needs. West Virginia, of the Eastern states, ranks first in the production of natural gas, and from this state is derived the major portion of the gas consumed in Pennsylvania and Ohio.

It is now customary to extract the gasoline from natural gas. This is done for a twofold purpose, viz.: To secure the gasoline and to rid the gas of this constituent as it condenses in the pipes and furthermore eats away the rubber gaskets. The heating value of the gas is only lowered about 2 per cent, and hence the extraction is justifiable. By the absorption method about .25 gal. of a gasoline is obtained from 1,000 cubic feet of gas. By the compression method from one-half to five gallons is obtained.

Calloidal Fuel.

Another fuel that has received considerable attention especially in connection with marine boilers is "colloidal fuel." This is produced by mixing powdered coal or coke with oil in which the coal is carried in suspension. The proportions of coal in oil vary, but 30 per cent of coal to 68 per cent of oil is a commercial mixture. The fuel is fed to the furnace the same as oil and is atomized by air or steam. The Btu content per gallon changes as the quantities of coal and oil change. A gallon of fuel oil from California will average 147,200 Btu per gallon, while colloidal fuel contains 160,000 Btu. The carbon is secured from anthracite or bituminous coal, or from coke. As a fuel this mixture would probably prove satisfactory but whether it will be used extensively depends on its cost. The expense entailed in producing it must be covered by a greater heating effect.

Powdered Coal.

Another method of burning coal is by reducing it to a powder and introducing it into a furnace in this form. The advantages of this method are an increased efficiency and a substantial decrease in the labor required for handling it. It is imperative that the present day wasteful processes for obtaining heat from coal must be superseded by others which will render available a higher percentage of the heat value of the coal. Without doubt this desirable end is attained when coal is burned as a powder and hence we can look forward to a more general adoption of this method of burning coal. In the cement, steel and copper industries, the use of this fuel has been firmly established and at present it is being applied to furnaces for the generation of power. This latter field is indeed an ideal one for powdered coal, due to the characteristic of the fuel. In the anthracite regions of Pennsylvania there are huge banks of culm which can be burned by this method. The cost at the mine for this coal is from 50 cents to $1 per ton, so that it presents a very attractive proposition from an economic standpoint. The Btu content will average about 10,000 per pound with a very low ash and sulphur content. An attractive feature connected with the use of coal powdered is the wide range of coals which can be consumed. This range includes both the analysis of the coal and the physical condition. Fine coal can be pulverized and burned as well as large lumps.

Gas Producers.

Gas producers find their most extensive field in the melting of steel and glass and in high temperature heating. They give the best results when gasifying a high volatile coal low in ash. There has been some difficulty at times in securing a coal of the correct composition and this has worked to the detriment of the producer.

Any successful development which will obtain a greater return from our fuels will secure either:

First—A more efficient generation and utilization of the heat of the fuel or

Second—An increase in the value of the raw fuel as measured by its by-products or

Third—Greater adaptability of the fuel in a changed form or

Fourth—A combination of the above features.

The underlying motive in any development will, in practically every case, be a reduction in heating cost. In some cases fuel cost is sacrificed to obtain an increase in the quality of the article heated in which case the enhanced value of the finished article will compensate for the monetary loss in fuel.

Analyzing the advances and developments in the past it is evident that they have conformed to the above mentioned principles. Thus the distillation of coal at low temperatures has as its object the production of liquid and gaseous by-products and a semi-coke which latter can be used as a fuel for domestic purposes. The sale of the by-products will more than meet the expenses incurred in the operation by which these and the coke are produced. Another instance is the burning of coal after it has been pulverized. By this change of form a higher percentage of the potential heat is rendered available and its field of application is extended.

Various methods for distilling coal have been brought forth. These may be classified under two heads. The first class comprised those processes in which gas alone is obtained as in certain types of gas producers. The second class covers those processes in which besides a gas, various other products are derived. One ton of coal when gasified in a producer such as supplies gas to an open hearth furnace will give off on an average 120,000 cubic feet of gas of 175 Btu content per cubic feet. This same ton of coal distilled in a by-product coke oven, will give from 65 to 70 per cent of coke and about 11,000 cubic feet of gas whose Btu content will average 550 to 600 Btus per cubic foot. Six thousand cubic feet of this gas will be surplus while 5,000 cubic feet will be burned to furnish heat to distill the coal. Other products obtained will be 12 gallons of tar, 2¼ gallons of benzol, 20 pounds of ammonium sulphate.

The benzol is taken from the gas, depriving it of approximately 6 per cent of its potential heat. During the war it was the practice to debenzolize the gas from coal whenever the volume was great enough to make the practice profitable. The coking of coal in by-product ovens as shown above, tends to conserve the constituents of the coal and in this way enhance the value of each ton gasified. As a source of heat besides the coke, 6,000 cubic feet of gas of say 550 Btus per cubic foot is available. In the gas producer, 120,000 cubic feet with a Btu content of 175 can be used for heating purposes. Financially the by-product oven is much more renumerative.

Consideration of High-Speed Turbine Gears

Notes on the Design and Operation of Turbine Gears. Historical Sketch of Development—Combined Reciprocating Engine and Turbine Drive on Wire Mill.

By GERALD STONEY.

THE function of a gear is to connect two or more pieces of mechanism that are required to rotate at different speeds of revolution. As a rule, each mechanism has a certain speed at which it is most efficient, and has only a moderate range of speed above and below that speed at which it is reasonably efficient; so that unless a sufficiently good compromise can be made between the requirements of the driven and the driving mechanism some sort of gear is a necessity. Thus gearing is necessary to enable the slow-running mill engine to drive the high-speed cotton spindle. On the other hand, direct coupling can be adopted with efficiency between the cylinders of a locomotive and its driving wheels, or between the reciprocating engine of a steamer and the propeller.

It is interesting to notice, in connection with the latter case, that in the middle of the last century there was difficulty in getting the reciprocating engine of that date to run fast enough for the propeller, and gearing-up was in some instances adopted.

In the early days of the electric transmission of power, chiefly used at that time for lighting, gearing had to be used between the slow-running reciprocating engine and the fast-running dynamo; and this was generally carried out by means of belts or ropes. With increased powers to be transmitted, troubles increased; and a great improvement was effected when the late Mr. Williams brought out (about 1884) his high-speed engine which could be coupled direct to a slow-speed dynamo. At about the same time the Hon. Sir Charles A. Parsons, K.C.B., F.R.S., made his compound steam turbine, in which, by reducing the speed of the turbine as much as possible and increasing the speed of the dynamo as much as possible, direct coupling became practicable. His first turbo-dynamo, made in 1884, ran at 18,000 rpm, and was of 10 hp; and it may be said that the design of a dynamo able to run at speeds suitable for a turbine was quite as great an invention as the steam turbine itself. Without this invention, the turbine would never have developed as it has done; and the difficulties in connection with the dynamo were probably greater than the turbine difficulties.

Similarly, when, in 1894, experiments were started by Sir Charles Parsons upon the utilization of the steam turbine for marine propulsion, the great difficulty was to get the propeller speed sufficiently high to allow of its being coupled direct to the turbine; and it was only after long and costly experiments that a workable compromise was reached. Despite the enormous development of the steam turbine for marine propulsion, one must remember that without gearing it was limited practically to high-speed vessels of over 16 knots, and could not be applied to the great class of cargo ships running from 8 knots to 12 knots. The whole of these difficulties were swept away by the introduction of gearing which enabled both the turbine and the dynamo or propeller to run at their most efficient speeds.

The problem of driving cotton mills and other mills by steam turbines has also been solved by the introduction of gearing. The present position is that gearing is used in all cases for large powers, except in the case of steam turbines driving alternators, where it is found that a satisfactory alternator can be made for speeds suitable to the steam turbine: but even here, for small sizes of, say, 500 kw to 2,000 kw, a high-speed turbine is often geared to an alternator of moderate speed.

With reference to types of gearing suitable for use with steam turbines; rope, chain and belt gearing are all impracticable, and the only types used are hydraulic, electric and helical. Ordinary spur gears do not run well at high speeds, and in all cases, therefore, helical gears are used.

With a few exceptions, the gear universally used is the helical gear, which, among other advantages, possesses the highest efficiency, between 98 per cent and 99 per cent.

The helical gear was first introduced in connection with steam turbines by De Laval, about 1889, in connection with his well known single-stage turbine, which had necessarily to run at a very high speed—about 30,000 rpm for a 10 hp and 10,000 for a 300 hp turbine. There was a single double helical pinion on the turbine shaft, and two low-speed wheels coupled to two dynamos, one on each side of the pinion. By this device, bending of the pinion was avoided if the loads on the two dynamos were equal; but, of course, the twist of the pinion had to be taken into account.

Helical gears for geared turbines are invariably made with involute teeth, which have this advantage among others, that the centers can be slightly varied so as to give the desired clearance between the teeth —for it is found that this must be suitably adjusted so as to be neither too little nor too much. Another point is, that such gears can be generated from a hob with straight sides, thereby securing simplicity and accuracy in manufacture. The angle of the hob varies somewhat in practice, but usually the angle of obliquity of the tooth adopted is that of the Brown and Sharpe tooth, namely, 14½ degrees. It is requisite that the bottom of the tooth be well rounded and have no sharp angles; and it is surprising that this precaution is so often neglected in gears of all classes. The angle of the tooth relative to the axis of the first gears was about 23 degrees, but 45 degrees has been very largely used; for the larger angle has been found to

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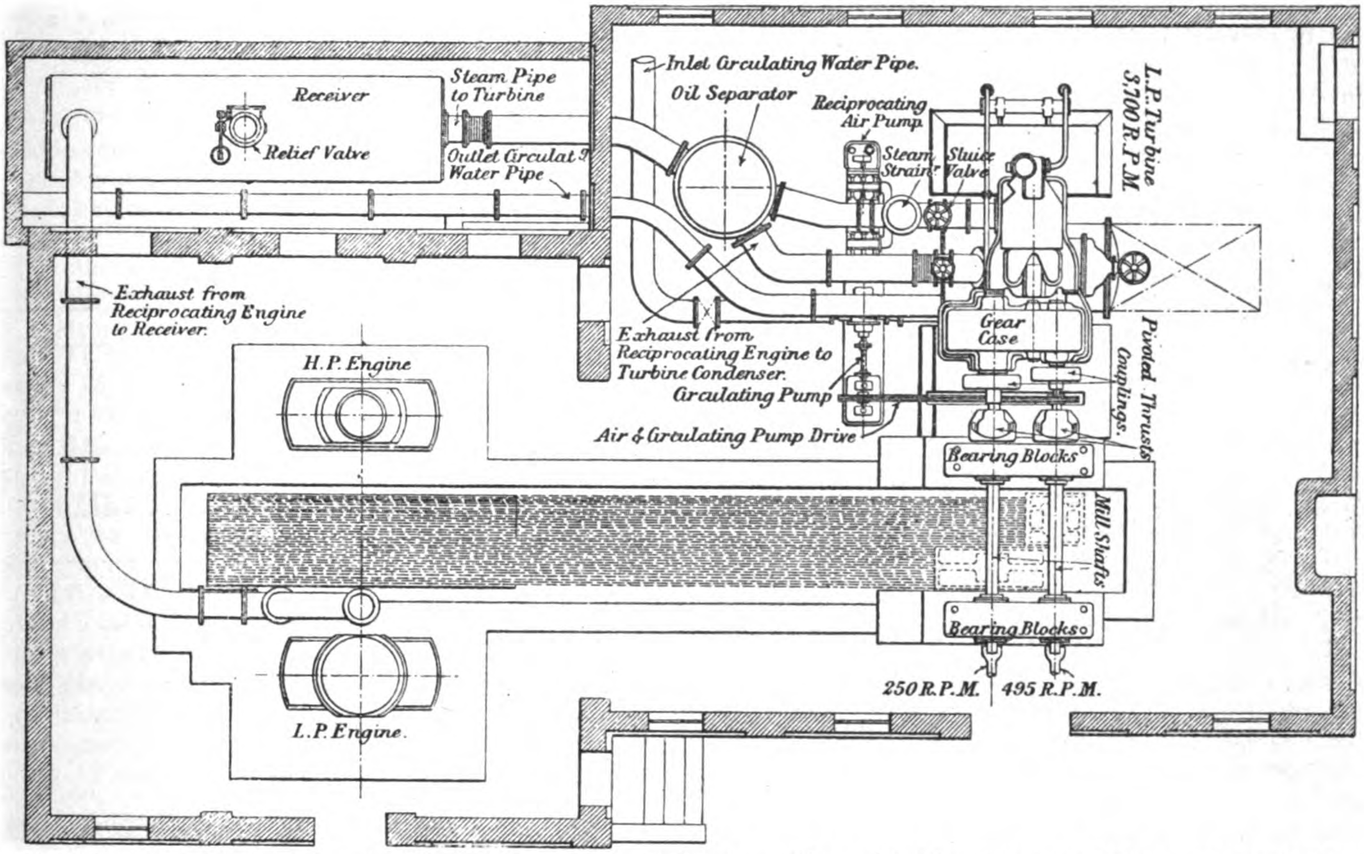
conduce to silent running. There seems to be a general opinion, however, that 45 degrees is rather too large; and the angle now generally adopted is about 30 degrees.

With reference to pitch; fine pitches seem in most cases to give more silent running at high speeds; and a normal pitch, that is, the pitch measured at right angles to the teeth, of 0.583 in. (or 7/12 in.) has been largely used in this country (Eng.) with about 0.4 in. for small pinions or where extreme silence is of importance. In the United States larger pitches, of 0.9 in. or even more, are often used.

The minimum number of teeth in a pinion is 19 with normal addendum and dedendum; but 22 to 25 is preferable. A peculiarity of involute gear is that by varying the addendum and dedendum interference can be avoided, and thus smaller numbers of teeth than these can be used in certain cases.


Receiver
Relief Valve
Steam Pipe to Turbine
Outlet Circulat'g Water Pipe
Inlet Circulating Water Pipe.
Oil Separator
Reciprocating Air Pump
Steam Strainer
Sluice Valve
L.P. Turbine 3,700 R.P.M.
Gear Case
Pivoted Thrusts Couplings.
Exhaust from Reciprocating Engine to Receiver.
H.P. Engine
Exhaust from Reciprocating Engine to Turbine Condenser.
Circulating Pump
Air & Circulating Pump Drive
Bearing Blocks
Mill Shafts
Bearing Blocks
250 R.P.M.
495 R.P.M.
L.P. Engine.

Combination of geared turbine and reciprocating engine. This wire rolling mill drive has two shafts running at different speeds. By connecting the exhaust turbine to the reciprocating engine a 58 per cent increase in power was obtained with no increase in steam used.

The whole gear must be supplied with an ample amount of oil, which is generally squirted under pressure from nozzles against the teeth where they come into contact with one another. This large supply of oil is necessary not only to lubricate the teeth but also to carry off the heat that is generated, and it is usual to have ¼ inch to 3/16 inch nozzles of about 5-inch pitch, squirting oil under a pressure of 10 pounds to 20 pounds per square inch on to the line of contact between the gear wheels. The quantity of oil is about one gallon per minute for each 100 hp to 150 hp transmitted. The gear-case must be well drained, for if the wheels were allowed to dip into oil at the bottom much heat might be generated by the churning of the oil.

The power that can be transmitted by a pinion depends upon the allowable tooth speed, the allowable load per inch run, and the allowable distortion due to the deflection and twist of the pinion, which must be so small that the distribution of load on the teeth remains practically constant. Further, the stresses on the material must be within safe limits. All these limits can only be determined by actual practice, and in this country a conservative policy was very wisely decided on, and as experience was gained the allowable power transmitted by any given pinion was increased. One result of this policy has been that failures of gears have been few and far between; in fact, the gear is quite as reliable as other parts of an installation, if not more so.

Tooth speeds up to 120 feet per second are common and have in many cases been exceeded. What is exactly the limit of speed is uncertain; but so long as lubrication can be maintained, there does not seem to be any reason why the figure given above should not be considerably exceeded.

The load on the teeth is generally reckoned in pounds per inch run, and is, of course, the same whether per axial inch or per inch of tooth along the helix. It is determined by the safe limit of bending stress on the tooth and of the pressures at the points of contact, as well as by danger of the oil film failing. The bending stresses are in practice very low, and can in general be ignored. For similar crushing stress on the material of the tooth, the load per inch run will vary directly as the diameter; or $p = a\,d$, where p is the load per inch run in pounds, d is the pitch diameter of the pinion in inches, and a is a constant. Similarly, the stress on the oil film will obey some such law as $p = b\,d^n$. The whole theory of the lubrication of gear teeth is a most difficult one, and one that has been only partly worked out. It is not proposed to deal with it here; but reference may be made to a paper by H. M. Martin in "Engineering" (Vol. 102, page 119, August 11, 1916), in which a reason is given for the assumption often made that $p = b\sqrt{d}$. These two conditions mean that up to a certain diameter $p = a\,d$, and that above it $p = b\sqrt{d}$.

In England, Messrs. Parsons, who were the pioneers in these gears, very wisely resolved not to exceed $a = 80$ and $b = 175$; but as experience has been gained b has been increased first to 220 and now to 250, and other makers of gears seem to have followed the same lines closely. In America, Mr. McAlpine has adopted a value for a of 105, and has ignored b. He claims to be able to use these high loads by the use of his floating frame gear; but is is only experience that can show whether such a device has any advantage and whether such high loads are safe. It is much better to keep to moderate loads in the early days of such gears; and we are still only in those early days.

With regard to the distortion of the pinion; this is made up of two items—the twist of the pinion due to the torque it transmits and the bending due to the load on the teeth. In estimating these it may be assumed that the load on the teeth is uniform along the pinion—or, in other words, that the torque diminishes uniformly from the driven end to the free end of the pinion. It may be further assumed that the effective diameter of the pinion is the pitch diameter.

The general practice in England is to have a rigid gear, and it is found that the distribution of wear along the teeth is quite uniform, without the necessity of such an arrangement as the floating frame. In this regard it must be remembered that the distortions in question are very small, never exceeding one-thousandth of an inch, and that the inevitable elasticity of a rigid gear-box helps to diminish their effect. Besides, the oil film in the bearings is of very considerable thickness, probably of the order of several mils. Little is known about the thickness of the oil film in a high-speed bearing; but there is evidence to show that its thickness is very considerable, and that it must be fairly thick is further shown by the clearance that has to be given in a high-speed bearing. This clearance is from 2 mils. to 3 mils. per inch diameter, and thus is very large in comparison with the distortions to be dealt with. A very small variation in the thickness of the oil film will therefore compensate for the distortion of the pinion.

The rigid gear is the usual design adopted in England; and the experience with some 16,000,000 hp of gears that have been constructed or are on order is, that it works excellently and is most reliable and efficient. On the other hand, the floating-frame type of gear is used largely in America, and is said to give excellent results; but it is a question whether such a device is necessary and whether quite as good results cannot be obtained by the rigid gear as adopted generally here. It is claimed that higher tooth loads can be used by the adoption of a floating frame; but only experience can show whether such a claim can be substantiated. Very wisely, the policy adopted here has been to go very cautiously until sufficient experience is gained.

Another type is the Alquist gear, in which the gear wheel is made up of a series of plates so as to give flexibility; but it does not seem to have been much used.

It is not proposed to describe in this paper the application of such gears to marine work, which is, of course, by far the largest application of the geared turbine; but a few typical instances of its application to land work may be of interest.

An example of the combination of a geared turbine with a reciprocating engine is shown in Fig. 1. It shows a plant by Messrs. C. A. Parsons & Co., Ltd., for driving a wire rolling mill, having two shafts running at different speeds. The compound reciprocating engine runs at 80 rpm and is supplied with saturated steam at 160 pounds pressure, originally exhausting into a central condenser at about 14 inches vacuum, giving 2,100 hp. By allowing it to exhaust at 16 pounds absolute and leading the steam into a turbine, exhausting into a condenser with 28.8 inches vacuum (barometer 30 in.), the engine gave 1,650 ihp, and the turbine 1,663 ihp, or a total of 3,313 ihp, an increase of 58 per cent in power with no increase in steam used, giving an increased economy of 36.6 per cent. The exhaust turbine runs at 3,700 rpm, and the geared shafts at 500 rpm and 250 rpm. The difficulty of the uneven turning moment of the reciprocating engine and the even turning moment of the steam turbine straining the gear is met by the flexibility of the rope drive. For starting up, the reciprocating engine can be exhausted to atmosphere.

It may be noted that if the power supplied to each low-speed shaft is equal, there will be no bending of the pinion, and the only distortion will be that due to twist.

An interesting example of a geared turbine device is that of an English cotton mill. The speed of the turbine is 3,000 r.p.m., and it drives a rope drum 3 feet 10 inches in diameter by 4 feet 10 inches long at 400 r.p.m., through a reduction gear with 24-inch centers, having a reduction ratio of 7.5 to 1. The drum takes 30 1¼-inch ropes and transmits 700 hp. In this case the whole of the expansion from 160 pounds per square inch, 200 degrees F. superheat, to 26¾-inch vacuum (barometer, 30 inches), is carried out in a single 700-hp. turbine. The steam consumption is 13.9 pounds per shaft horse power.

Editor's Note—This paper is abstracted from a paper read before the Manchester Association of Engineers as it appeared in London *Engineering*. The illustration used is also taken from *Engineering*.

Comparative Welding Tensile Tests

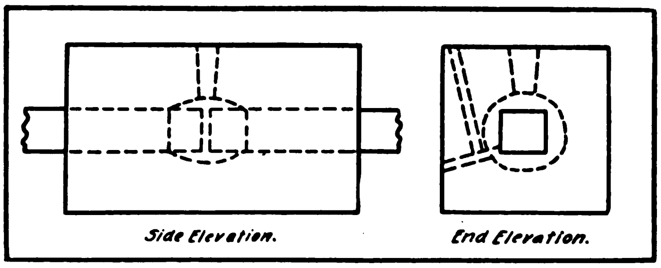
Description of Method of Welding Tie Rods at the Algoma Steel Corporation by the Thermit Process—Work Done Under Difficult Conditions.

DURING the month of August the Algoma Steel Corporation, Ltd., Sault Ste. Marie, Can., had a rush job to do in the way of welding some 13 pieces of 3¼ inch square rods, each rod to be welded in three places, making a total of 39 welds.

These rods were used as tie rods from a concrete ore dock back to an anchor wall, making the rods in all a length of about 185 feet.

The nature of the subsoil and the excessive loads of ore placed in storage back of the dock proper made it necessary to get a substantial tie back to prevent any slip in the dock.

Rods were placed at an elevation of about three inches above normal lake level but due to high water in the lake at the time the work was going on the rods were frequently submerged and work had to be rushed during the periods of lower water.



Construction of mold box for welding tie rods.

The first seven or eight welds were made by the electric process and one of these welds cut out and tested the result of which was as follows:

	Tensile strength per sq. in.	Elongation
Section of original bar........	60.100 lbs.	40%
No. 1 test on electric weld....	18,700 lbs.	0%
No. 2 test on electric weld....	13,280 lbs.	0%
No. 3 test on electric weld....	16,500 lbs.	0%

or an average of 16,160 pounds which was only about 27 per cent of the original bar, and as 65 per cent was necessary the electric welds were condemned and all cut out and the thermit weld used in its place.

Sample thermit welds were made out of a piece of 3¼-inch square bar and the tests obtained on this sample were as follows:

	Tensile strength per sq. in.	Elongation
Original bar	48.560 lbs.	52.5%
No. 1 thermit weld...........	27.500 lbs.	2.5%
No. 2 thermit weld............	52 200 lbs.	6.0%
No. 3 thermit weld............	44 880 lbs.	4.0%

or an average of over 85% of the original bar.

In connection with these tests thermit sample one had a slight pipe in it which reduced its tensile strength considerably but sample No. 2 was an almost perfect weld and tested up stronger than the original bar.

In preparing the sections for the tests of both electric and thermit welds, a piece of the 3¼ inch square rod about 7 inches long containing the weld was cut out. This was put in a crank shaper and machined to flat surfaces on three sides, then put under power hack saw and quartered. Three of these quarters were then turned down to test pieces having cross sectional area of 0.7854 square inches or about 7½ per cent of the original bar.

The results of the tests made were so satisfactory that it was decided to use the thermit weld in spite of the difficulties to be encountered.

Boats were due at the dock any day within a week and the water was high with not sufficient time to properly cofferdam each weld, however, by the use of a steam pump and constant bailing the water was kept low enough to get at the welds and work started on July 9 and was completed on July 17.

SPECIAL APPLICATIONS OF METAL-RADIOGRAPHY.

(Continued from page 146)

through the adjacent sound metal. Another application was made of X-rays in the study of specimens which were to be tested as to their behavior under reversed stresses, i.e., fatigue tests. The interior condition of three typical specimens which were of the shape and size for the Upton-Lewis machine is shown in the radiographs of Fig. 1 (A, B, C). In this case as before, the specimen was so placed that the path of the rays was parallel to the plane of the flake. The type of fracture produced in the fatigue test for each class of steel were of interest. As might be expected the material showing no evidence of the flakes broke with a smooth porcelain-like fracture, the others show large conspicuous crystalline areas in the face of the fracture corresponding to the flakes. This application of radiography to the examination of test specimens, particularly those tests which are expensive either from the viewpoint of the time required to carry one to completion or of the extreme care which is required in shaping the test specimen, is probably one of the most important applications which can be made of metal-radiography. In the investigation of arc-welded materials now in progress at the Bureau of Standards it is proposed to examine all specimens for the impact and the fatigue tests in this manner in order to locate any serious defects such as are quite common in welded materials which would vitiate the results of the test.

Other applications of the method have been made mainly of a miscellaneous character, however. One such examination was of complex mixtures such as copper-lead bearing metals in which the fineness of the grain of the mixture which can be detected by X-rays is very surprising.

FOREIGN RELATIONS

BELGIAN INDUSTRIAL SITUATION.

Trade Commissioner C. E. Herring, Brussels.
Commerce Reports.

The resumption of the Belgian basic industries during the month of November was retarded by continued lack of raw materials, acute shortage of coal and coke supplies, and increasing scarcity of rolling stock for receiving materials and making deliveries. Further depreciation of the franc, enhancing the price of raw materials and semi-manufactured goods purchased abroad, is another important factor in the industrial situation. The following brief resume of the chief Belgian industries on December 1 may be of interest to American manufacturers and others.

Coal Production—Need of Coke-Producing Coal.

During November coal production reached about 98 per cent of the output in 1913; in some basins the percentage surpassed pre-war production. Unfortunately the heavy exports and the lack of facilities for distributing supplies, together with insufficient production of coke-producing coal, continued to jeopardize the reviving industries of the country. The transportation crisis has grown much worse since October 15, and large stocks are on hand in various collieries. It is said in the Charleroi district some 750,000 tons of coal are held in stock, while some 200,000 tons are awaiting shipment in the Borinage district.

The failure to receive promised shipments of industrial coal from the Ruhr region, and the great difficulty of obtaining coke-producing coal from other foreign sources is very unfortunate. The prices of industrial coal from overseas are almost prohibitive, even if supplies were obtainable; for instance, Yorkshire coking coal is currently quoted at 120 shillings per ton c.i.f Antwerp, while Durham coal is quoted at 130 shillings per ton. The government has recently conferred with important coal producers in an effort to insure a more scientific distribution of Belgian coal to plants in urgent need of it. Coke production in Belgium continues far short of normal and no export licenses whatever are being granted.

Difficulties of Iron and Steel Industry.

The iron and steel industry is greatly hampered by lack of fuel supplies. Normal steel production in Belgium would require 80,000 tons of coke monthly, and present production is far below this figure. The lack of ores and other raw materials continues, and this, together with fuel shortage, delays the opening of new blast furnaces. Rolling mills completely or partially restored are unable to resume normal production because of the excessive prices and difficulty of obtaining deliveries of semi-finished products.

Belgian steel production has now reached about 17 per cent of the pre-war output. Iron and steel prices continue to advance steadily, and it becomes increasingly difficult to guarantee prices for future delivery. The export demand continues very strong, and export prices are said to be somewhat higher than quotations for domestic deliveries.

State Railway Budget.

In 1913 the budget of the Belgian state railways amounted to about 243,200,000 francs while the estimates for 1919 provide for expenditures of 559,200,000 francs, or an increase of 130 per cent. As elsewhere, the factors contributing to this enormous increase in operating expenses are the cost of coal and other raw materials, as well as of rolling stock, etc., the high cost of shopwork, and the increase in wages of trainmen.

Reclamation of Stolen Property.

The Belgian service for reclaiming machinery and miscellaneous articles taken away by the Germans sent back to the Belgian factories during the month of September 2,262 pieces of machinery and 18,095 kilos of other goods.

NOTES ON GERMAN INDUSTRY.

Consul Francis R. Stewart, Berne, Switzerland.
Commerce Reports.

The temporary shutdown of passenger train service in Germany had a good effect upon the traffic in coal, but was somewhat offset by the freezing temperature and heavy snowfalls. The tension in the iron and steel trade continued in full force throughout November. The production and the daily output were somewhat increased. The capacity of the mills has been still further reduced by the present shortage of coal and lack of transport facilities and auxiliary materials. Of 62 blast furnace plants, eight are already shut down; and of 319 steel mills, 53 are closed. The situation in the iron trade is still strained and confused. The demand is lively, the available material so scarce that the requirements cannot nearly be covered. The factories have booked orders up to their capacity for many months to come. This report is dated December 12, 1919.

INDIA INCREASES STEEL CAPACITY.

The urgent need for iron and steel in England France, and America for shipbuilding and to make good the wastage of modern war, at a very early stage, largely deprived India of external supplies of iron and steel. India was thrown on its own resources, which are still insufficient to meet its demands. As a result, it was necessary to organize the iron and steel trade to meet demands. The Tata Iron & Steel Co., have undertaken very large extensions. The Bengal Iron & Steel Co. also proposes to take up the manufacture of steel at Kulti, and a more recent company, the Indian Iron & Steel Co. (Burn & Co., managing agents), will make pig iron and steel at Asansol. The blast furnace to be built for the latter company was described in the January number of the BLAST FURNACE AND STEEL PLANT, page 28.

LAST YEAR'S DECLARED EXPORTS FROM FRANCE TO UNITED STATES.

Cablegram from Consul General A. M. Thackara, Paris, dated January 16, 1920.

The value of the declared exports during 1919 at American consulates and agencies in France to continental United States was $163,831,429, against $54,678,118 in 1918; to Philippine Islands $1,441,591, against $1,273,724; to Porto Rico, $127,971, against $85,418; to Hawaii, $591, against nothing; to Virgin Islands, $109, against $867, making a grand total from France to the United States and insular possessions of $165,401,691 in 1919, against $56,038,127 in 1918, an increase of 191 per cent. The above figures do not include shipments from Nice.

AUSTRALIAN PROHIBITION ON TRADING WITH ENEMY COUNTRIES.

The commissioner of Australia in the United States has received a cablegram from the Australian comptroller of customs stating that a proclamation was issued on January 14, 1920, prohibiting the importation of any goods manufactured or produced in or brought directly or indirectly from Germany, Austria-Hungary, Turkey, or Bulgaria, except with the consent of the Minister for Trade and Customs. Goods shall be deemed to have been manufactured or produced in Germany, Austria-Hungary, Turkey, or Bulgaria if more than 5 per cent of the invoice value thereof has been derived from labor of persons resident in any of those countries and (or) from material obtained from any of those countries, and the burden of proof of the country of manufacture or production within the meaning of these regulations shall lie on the importer.

PRODUCTION TOPICS

THE FUNCTION OF OIL BURNERS IN THE OPERATION OF FURNACES.

The natural advantages of oil fuel have led to the development of many appliances designed to further its use, the most common of which are the so-called "oil burners." In the early days of burning oil it was generally assumed that the most essential requirement was an "efficient oil burner," and such opinion is still quite common even though years of development have conclusively proved it to be in error. This assumption is responsible for a general misunderstanding of the real principles involved, and has in no small measure retarded progress in the efficient use of oil fuel. It also has retarded progress in the development of heat-treatment work, largely because there is not proper appreciation of the difference between "burning oil," "making heat" and "properly applying heat to produce a uniformly heated product." The latter is the result actually sought for, everything else being a means to that end.

Generally speaking, there is no such thing in industrial heating as an "oil burner" in the sense that is considered with a gas burner or the burner of an oil stove or lamp. The very term is a misnomer, because the type of "oil burner" is generally used for furnace work is not an appliance to burn the oil but merely a regulating, mixing or atomizing valve to inject the fuel and air into the furnace, in which it actually is ignited and consumed. The oil itself does not burn; it is a mixture of gas and air which burns. The gas from the oil generally used for fuel is generated under the action of heat at high temperature in the zone of combustion. The air may be supplied through or induced by the burner or in some other manner, and the supply must be regulated in proportion to the fuel to obtain proper results.

The real "efficiency" of an oil burner is mainly mechanical, as with any other type of spraying, injecting or mixing valve. Some types of burners may produce better results than others in atomizing or mixing, or from an operating standpoint offer greater convenience in cleaning, adjustment interchangeability of parts, etc., but in general the efficiency is more mechanical than thermal.

The fuel consumption is determined primarily by the requirements of the furnace, and is largely influenced by the method of operation and not by the mechanical details of the burner itself. A great deal of oil is burned successfully on certain types of furnaces without the use of oil burners at all; in others, the operation is conducted with air pressures so low that there is practically no atomizing effect from the burner, which serves merely to inject the air and fuel. Excellent heating results, with material reduction in fuel consumption, have been produced with new furnaces of improved design operated with old burners which have been in constant use for over 20 years.

There are some special forms of oil burners, such as torches for brazing, drying, lighting cupolas, spot heating, etc., with provision for maintaining combustion after a gas has been generated by heat and ignited, but these differ from the type generally used in connection with furnaces and designated by the term "oil burners." On account of the high temperature necessary for the combustion process and the resultant expansion, contraction, and oxidation, these devices burn away in time. While very well adapted to these specific heating operations, which cannot well be conducted with a furnace, their use is unnecessary and unwarranted for general furnace operation.

A properly designed oil furnace is in reality a combination of a gas producer and a furnace and should be considered as such. The oil generally used for furnaces must be converted into a gas before it can be consumed, and this gasification process is conducted at a temperature too high for ordinary metal to withstand. When the nature of the heating operation and the design of the furnace will permit the gasification of the fuel within the furnace it is desirable that the process of gasification be conducted in a chamber lined with refractory material. This refractory combustion chamber is necessary on account of the temperature that must be employed to actually gasify the oil without deposits of carbon or tarry matter, which naturally follow any attempt to gasify oil at low temperatures. With the oils employed as fuel for furnace operation, the high heats are absolutely necessary because it is impossible to form the gas by mixing the oil and air, or by mixing air with the vapors of the oil—as in automobile practice—on account of the fact that these oils can be only partially gasified without heat.

Years ago it was thought necessary to convert the oil into a gas and deliver the fuel as gas to the furnace.

This unnecessary complication gradually brought about an appreciation of the fact that, with proper design and operation of furnaces, this work of gasification could be accomplished in the comparatively small space occupied by a suitable combustion chamber. This without any loss of heat outside of the furnace in gasifying the oil, difficulty in starting, and risk or discomfort to the operator by radiation or contact with the gasifying equipment or by the explosion hazard incident to the movement of combustible mixtures through pipes. For these reasons, if the nature of the heating operation and the size of the furnace will permit the use of oil, it is better to gasify the oil at high temperature in a refractory combustion chamber within the furnace. But when the nature of the heating operation and the size of furnace make it desirable to employ a gaseous fuel, then that gas should be generated in a central station at a point distant from the furnace, and the gas, whether it be made from coal or oil, should be scrubbed of its tarry matters so that it may be delivered as a clean, cold fuel through a pipe, after the manner of the gas service in cities. In some cases, when the heating operation and manufacturing conditions make a gas fuel desirable, and the gas made from coal is, by reason of its chemical composition or cost, unsuited to the operation, it is in order to consider the use of gas made from oil. To produce this gas it is necessary that the oil or a mixture of oil and air be injected into a retort heated to the temperature necessary to break up the oil and convert it into a fixed gas, and, in addition, to scrub and cool the gas so that it may be delivered through pipes without forming deposits. This is a true gasification process. Oil and air may be mixed at low temperatures and if the oil is thoroughly atomized an oil vapor may be formed. However, this is not a gas and cannot be considered as such until it has been subjected to the temperature that is absolutely necessary for true gasification.

There is no one type of burner suitable for all heating requirements. The essential features are that it be properly proportioned to the oil and air or steam pressures available, and so designed that all parts are accessible and permit of close adjustment, cleaning and convenient removal from the furnace without affecting the operation of any other burner served by the same piping system. The position of the burner and arrangement of piping are determined by the design and location of the furnace.

The same general rules apply whether the oil burner is of the high pressure type using steam or compressed air, the straight low pressure type using moderate air pressures, or of the combination type.

There are no fixed rules that can be laid down to deter-

A paper presented before the convention of the American Steel Treaters Society, Chicago, Ill., September 23-27, 1919.

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PRODUCTION TOPICS

mine whether air or steam should be used or the pressure at which it should be delivered, because the specific operating conditions of each case, coupled with the design of furnace, determine these points. The real test is the effect upon the finished material and the total cost of installation and heating operation.

There are certain cases to which steam, even at a higher cost is well adapted, but the conditions determining the use of steam are based upon the ultimate result in heated product and not upon any combustion condition. When steam is employed it must be as dry as possible and all lines well covered and trapped to avoid trouble from condensation. Higher pressures are more necessary with steam than air, not because the pressure is necessary for atomizing but because steam at a fairly high pressure will be comparatively dry when expanded at the burner tip. The existence of water seriously affects combustion, the character of heat in the working chamber, the brickwork of the furnace, and increases the operating cost. The use of steam with a properly designed and operated furnace produces excellent results for certain classes of work, giving soft, even heats. Steam requires more attention than air, but when the operating conditions make it desirable the difference in results is well worth the extra attention. The use of steam is limited to certain types of furnaces by reason of the space required, temperature or other manufacturing conditions and the necessity for inducing all the air required to support combustion.

There is no one air pressure or type of blower suitable for all conditions. The use of air at pressures above 4 or 5 pounds per square inch involves the use of piston driven compressors or other expensive water-cooled equipment, which are objectionable on account of the high cost of installation and operation. When the furnace equipment is small and compressed air is available, high pressures may be employed to avoid the installation of new blowing equipment; but as a general rule, in a new installation involving machinery to deliver air, the higher pressures are unnecessary.

In many cases, when the design of the furnace permits, air at 4 or 5 ounces or less per square inch may be employed to maintain clear fires without smoke or carbon deposit; in others, the design of the furnace makes it necessary to employ higher pressures in order to secure sufficient atomization of the fuel. When the very low air pressures are employed there is practically no atomizing effect—the air acting merely to support combustion and assist in the delivery of oil to the combustion chamber—the gasification of oil to the combustion chamber—the gasification being almost entirely brought about by heat and the action of the gases within the furnace.

The proper air or steam pressure to employ is invaribaly determined by local plant conditions and furnace design. Each case must be dealt with on its merits. The purpose should be to adapt the existing air or steam equipment to the furnaces whenever possible, so that the question in each case becomes one of delivering heated product at the lowest cost of installation and operation, all things considered.

High oil pressures are frequently employed for mechanical atomization of the oil without the use of air to assist in the atomizing process. This practice is common on marine and other large boilers for steam generation, and has many advantages in cases where thec onsumption per burner is relatively high, when the oil is of low gravity, and when the requirements for raising steam do not demand the refinement and control that is necessary for modern heat-treatment processes. The advantages of mechanical atomization in such cases do not hold good in the average heat-treatment plant, where, with properly designed furnaces, it is possible to secure the desired results without the mechanical equipment and high pressures necessary in boiler work. In average heating practice the actual pressure is not so important as the uniformity of flow, because there is a material reduction in pressure at the needle valve of the burner, so that the pressure of the oil as it enters the furnace is invariably less than the pressure on the line. A slight variation in oil pressure will react more readily on furnaces where the consumption is relatively small than on steam boilers where the pressure on the steam line is generally controlled by a regulating valve.

The combustion of oil is based upon the same principles as those governing the operation of an ordinary coal or gas stove, gas or oil lamp. It is essential that provision be made to regulate the supply of air in proportion to the amount of fuel required to make the proper heat. If this is not done, improper combustion is likely to result due either to insufficient air for the amount of fuel injected into the furnace, or an excess of air beyond that necessary to complete combustion. It may react in a waste of fuel due to the necessity of injecting more fuel than is necessary for the heating oepration in order to balance the execess air drawn into the furnace. This is what generally happens without proper control of all air entering the furnace. As the supply of fuel varies from the time of starting and the furnace is up to heat, it naturally follows that means should be employed to effect a corresponding variation in air supply. The burning of oil or any other fuel without provision to regulate every cubic foot of air supplied to the frnace, whether it is under pressure or not, results either in a waste of fuel or in a waste of material through inability to maintain proper heating conditions in the chamber.

The design and operation of the furnace, and not the burner, whether the burner be for oil or gas, determine the nature of the combustion, the manner in which heat is applied to the heating chamber, the amount of fuel required to heat the material, and the uniformity of temperature throughout the mass to be heated. No type of burner or method of preparing or delivering fuel to a furnace will remedy improper furnace design.

The ordinary oil burner bears about the same relationship to the operation of a furnace that the spraying valve of a carburetter does to the operation of an automobile. It is just as useless to expect good service from a poorly-designed or worn-out automobile through the attachment of a good carburetter as it is to expect perfect heating after attaching a good oil burner to a furnace which is not in condition to properly heat material after the heat is generated.

which is determined almost entirely by the furnace design.

Good combustion is not necessarily an indication of fuel economy in the operation of a furnace. It may be possible to show good combustion through analysis of flue gases and at the same time waste fuel in a poorly-designed furnace through improper location and size of vents, discharge of gases at unnecessarily high temperatures, excessive radiation through light walls or bottom, lack of control of the gases leaving the furnace, or difficulty of properly applying the heat to the material in the chamber, regardless of how good the combustion may be. It is possible to show good combustion in a furnace lacking provision to control the supply of air by delivering sufficient fuel to balance the air actually supplied. A good flue gas analysis from such operation is surely not an indication of fuel economy. It is possible to maintain relatively good combustion, with fuel economy ,in a furnace that would be well designed from the standpoint of utilizing the heat and yet very poorly designed from the standpoint of properly applying that heat to useful work. This is equivalent to maintaining good combustion in a good engine, the power of which is not applied properly to the driving wheels of an automobile. Unless there is proper heating of material or good results in the form of transportation, fuel economy in furnaces or automoblies is of little value; and unless there is proper design and operation of the furnace or automobile, oil burners or carburetters cannot in themselves produce the results sought for.

NEWS OF THE PLANTS

The Steel & Tube Co. of America, Indiana Harbor, Ind., is planning for the operation of its new lap mill at an early date. During the past year the company constructed two such mills at its local plant, and the new unit makes the third to be placed in service. The company has plans under way for the installation of new equipment at its coke plant, including new oil-cooling apparatus, stokers, coal-handling plant, oil scrubbers, storage tanks, and kindred equipment. This plant is located at Mayville, Wis., having formerly been the property of the Northwestern Iron Company.

The Shenango Furnace Company, Sharpsville, Pa., is now operating all three of its blast furnaces and producing about 1,400 tons of pig iron per day. No. 3 furnace was recently blown in after being relined and repaired.

The Titusville Forge Company, Titusville, Pa., has been organized to take over and operate the local plant of the Bethlehem Steel Company, which acquired the property about seven years ago. The new owner has arranged for a note issue of $1,150,000 for proposed business extensions. The plant will be used for the manufacture of hammered and pressed crank shafts for steam and gas engine service, and the company is said to be the largest manufacturer of such products in the country. A complete line of other forgings will be made up to about 40,000 pounds. The plant is fully equipped with necessary machinery and modern devices for economical operation, and is up-to-date in all particulars. The capacity of the works was more than doubled during its operation by the Bethlehem Steel Company. John T. Dillon, Jr., is president of the Titusville Forge Company.

The Youngstown Sheet & Tube Co., Youngstown, O., has commenced the construction of a new tube mill for rolling large sizes of pipe. The plant will have a capacity of about 5,000 tons of material a month, and is expected to be ready for operation during the coming summer. It will be fully equipped with rolls and general operating machinery.

The Worth Brothers Corporation, Claymont, Del., manufacturer of iron and steel products, is arranging an extensive building program for works expansion during 1920. It is planned to construct a number of additions to the plant for large increased capacity, bringing the output up to about 200,000 tons of material per year, or approximately twice the amount of present production. The new buildings will include rolling mill, furnaces, shear department, and numerous other structures, and all of these buildings will be provided with modern equipment to give employment to a considerable number of new men. New crane runways and electric-operated traveling cranes will be installed, with capacity for handling material of large tonnage. Construction is now under way on the erection of a new rolling mill, and this plant will give employment to close to 500 men. To provide for proposed improvements and extensions, the company has recently increased its capital from $2,500,000 to $5,000,000, and its affiliated organization, the Worth Brothers Steel Company, has made a similar increase in its capitalization. Norman R. Entrekin is general superintendent. Plans are also under way for an extensive housing development to include the erection of a large number of new homes for employes at the mill.

The Crucible Iron & Steel Co. Harrisburg, Pa., has plans under way for the reconstruction and enlargement of its No. 2 open-hearth furnace. The capacity of the plant will be increased. No. 1 furnace at the works was recently remodeled and the output increased from 60 to 120 tons capacity. When the work, as now planned, is completed, the open-hearth department at the plant will comprise six furnaces, four of 120-ton capacity, and two of 60-ton rating.

The Crucible Steel Forge Works, 6602 Grant avenue, Cleveland, O., manufacturer of iron and steel forgings, has completed plans for the construction of an addition to its plant for increased capacity. The work will comprise two new buildings to include rolling mill, heat-treatment and annealing plant, machine shop and other industrial departments, and is estimated to cost about $600,000, including equipment. S. W. Wells is manager.

Work is under way by the Follansbee Brothers Company, Pittsburgh, Pa., for its proposed new sheet mill plant at Toronto, O. The initial units to be constructed will comprise an open-hearth building, 180x360 feet, a bar mill, 100x300 feet; hot mill, 140x880 feet; annealing works, 92x820 feet; scrap shed, warehouse, and other auxiliary structures. The contract for the buildings has been let to the Belmont Iron Works, Philadelphia, Pa. Contracts for considerable equipment have been awarded and other machinery will be ordered at an early date.

The Utah Steel Corporation, Salt Lake City, Utah, is planning for extensive additions and improvements in its rolling mill department during the present year. The work will comprise the installation of an oil-heated continuous billet heating furnace to replace two coal-fired furnaces now in service. This furnace will be used for the finishing mills; a new motor-driven finishing mill and electric-operated overhead traveling crane of 5-ton capacity, and new hotbed for the 8-inch mill will be installed.

The Replogle Steel Company, Wharton, N. J., formerly known as the Wharton Steel Company, has plans under way for extensive enlargements and improvements to its local plant for increased production. The smallest of the three blast furnaces at the works will be razed, and two new furnaces, each of 600 tons rating, will be constructed. These furnaces will be of the latest type of construction, electrically-operated throughout. The present No. 2 and 3 furnaces will be remodeled and relined, and brought fully up-to-date in all respects; these furnaces have a capacity of about 500 tons each. Plans are also being prepared for the erection of a new electrically-operated ore bridge to convey the raw material from the storage bins to the furnaces. The company is also planning for the construction of a new steel finishing mill, and a battery of coke ovens, as well as a new sintering plant. The company has its own iron mines in this vicinity, and operates a railroad known as the Wharton Northern. The improvements at the steel plant will require from six to nine months to bring to completion, and will provide for the employment of a total of about 5,000 men at the plant. H. M. Roche is consulting engineer for the company located at the Wharton works.

The St. Joseph Structural Steel Company, Fourth and Franklin streets, St. Joseph, Mo., has completed plans for the construction of a new plant for large increased output. The works will be located at Eighth and Atchison streets, and are estimated to cost about $75,000.

The Open Hearth

C. W. ALEXANDER.

C. W. Alexander is now general superintendent of the Tata Iron & Steel Co., India. Mr. Alexander has had extensive experience in the steel industry in the United States, having formerly been general superintendent of the American Tube & Stamping Co., Bridgeport, Conn. Previous to which Mr. Alexander was acting assistant general superintendent of the Donner Steel Company, Buffalo, and open-hearth superintendent of the Cambria Steel Company, Johnstown, Pa.

V V

Julian Burdick was elected president and general manager of the West Penn Steel Company at the last annual meeting of the directors. Mr. Burdick who has been president of the company since its organization was elected chairman. John McGinley who has been general manager since the organization of the company was at his own request relieved of the active duties of the general managership and elected vice president. Mr. Burdick and Mr. McGinley will continue to devote their services exclusively to the management of the company, the business of which has so expanded that they desire to give more time to the general policies of the corporation.

V V

E. J. Kauffman has been appointed superintendent of the washed metal department of the Brier Hill Steel Company, succeeding T. M. Phillips, resigned.

V V

A. G. Egler has been appointed superintendent of the open hearth department of the Brier Hill Steel Company succeeding H. B. Barnhart, resigned.

V V

Daniel W. Kearcher has been elected director of the Eastern Steel Company, Pottsville, Pa.

V V

W. W. Lewis, who was formerly superintendent of the Western Reserve Steel Company before this company was taken over by the Brier Hill Steel Company, has recently been appointed superintendent of the Falcon Steel Company, Niles, O. George E. Harris has been appointed sales manager of the Falcon Steel Company.

V V

F. H. Maple has been made foundry superintendent of the American Steel Foundries at Alliance, O. Mr. Maple was formerly superintendent of the Point St. Charles plant of the Canadian Steel Foundries, Ltd., Montreal, Quebec.

V V

I. G. Brown has been made superintendent of the American Brakeshoe & Foundry Co., plant at Mahway, N. J. Mr. Brown was formerly assistant superintendent of this plant.

V V

Andrew Couts has resigned as superintendent of the annealing department of the Trumbull Steel Company, Warren, O., and is now connected with the Newton Steel Company, Newton Falls, O.

V V

J. E. Kelly is now foundry superintendent for the Lockport Foundries Corporation, Lockport, N. Y. Mr. Kelly was formerly connected with the Chain Belt Company, Milwaukee, Wis.

V V

E. Everette Fisher, formerly assistant to the president of the Laclede Steel Company, St. Louis, Mo., has been made sales manager of that company.

V V

J. P. Pero who has been general superintendent and sales manager of the Missouri Malleable Iron Company, E. St. Louis, Ill., for a number of years has retired from active duties.

V V

L. J. Campbell has resigned as vice president of the Youngstown Sheet & Tube Co., Youngstown, O., to assume active duties with the Electric Alloy Steel Company, Youngstown, O. The organization of this company was announced on page 132 of the January issue of THE BLAST FURNACE AND STEEL PLANT.

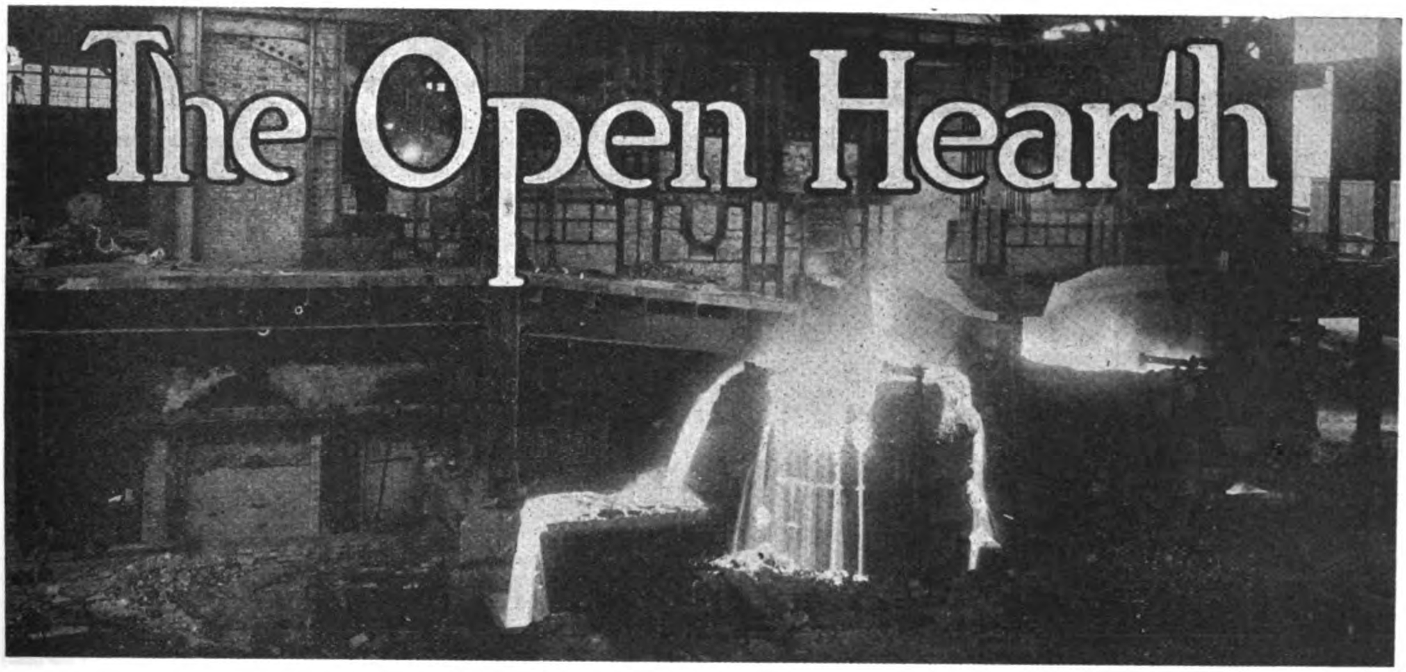
V V

A. H. Fosdick has been appointed assistant blast furnace superintendent of the Bethlehem Steel Company, Bethlehem, Pa. George M. Hohl is blast furnace superintendent.

V V

George W. Vary has been appointed superintendent of the employment and welfare of the Bethlehem Steel Company, Bethlehem, Pa., succeeding A. H. Fosdick.

The Open Hearth



Mr. Noyes.

The illustration at the left shows Mr. Noyes, works manager of the Broken Hill Proprietary Company, Ltd., steel works, Newcastle, Australia, standing in front of his office at that plant. The officials of the company are: G. D. Delprat, general manager; David Baker, general manager steel plant; J. M'Meaking, assistant manager steel plant; Mr. Noyes, works manager; Mr. Griffith, blast furnace superintendent; Dr. Gibson, construction engineer and Mr. Allen, civil engineer, construction department.

V V

S. S. Wales has been elected a director of the Electric Alloy Steel Company, Youngstown, O. Mr. Wales is chief electric engineer of the Carnegie Steel Company.

V V

J. J. Carr, previously general foreman of the Hull-Rust mine of the Oliver Iron & Mining Co., now located at the Missabe mine of the Oliver Iron & Mining Co.

V V

Stuart B. Marshall, consulting engineer and metallurgist, has established headquarters at Washington. Mr. Marshall was formerly general manager of the American Manganese Manufacturing Company and was connected with the Aluminum Company of America, at Roanoke, Va.

V V

Paul Caldwell, who for the past year has been sales manager in New York for the Cleveland Crane & Engineering Co., has resigned and has again taken up his former duties with the General Electric Company at their Pittsburgh office.

V V

Edward C. Smith, formerly assistant general superintendent of the Harrisburg Pipe & Pipe Bending Co., Harrisburg, Pa., has been appointed acting general superintendent succeeding W. P. Starkey.

V V

William LeRoy Emmet has been awarded the Edison Medal of 1919 for meritorious achievement in electrical science. Mr. Emmet has been consulting engineer for the General Electric Company at Schenectady for a number of years. Mr. Emmet designed the Curtis steam turbine and was also active in developing the electrical propulsion of ships.

John Fraser has been appointed consulting engineer for the Empire Tube & Steel Corporation, College Point, L. I. Mr. Fraser, who is a consulting engineer, 30 Church street, New York, has also been elected a director and vice president of the corporation.

V V

C. H. Bradley has recently severed his connection with Perin & Marshall of New York, to accept the position of assistant chief engineer with the Otis Steel Company, Cleveland, O. Mr. Bradley has previously been connected with the engineering departments of the Dominion Steel Corporation, the Algoma and the Tennessee Coal, Iron & Railroad Co.

V V

W. R. Tyson, who has been connected with the Tioga Steel & Iron Co., Philadelphia, Pa., has recently severed his connection with that company and is now manager of the sale of forgings of the Becker Steel Company of America.

V V

W. R. Phibbs is now Eastern representative of the James A. Brady Foundry Company, Chicago. Mr. Phibbs was formerly assistant general manager of the Steel & Tube Co. of America, Mayville, Wis.

V V

Joseph G. Butler, Jr., vice president of the Brier Hill Steel Company, Youngstown, O., is again able to resume his duties after having been incapacitated for six weeks following injuries received when he was struck by a motor truck.

V V

A. G. Ripberger, formerly connected with the engineering staff of the Illinois Steel Company, Gary, Ind., has accepted a position as chief engineer for the steel and tube department of the Timken Roller Bearing Company, Canton, O.

V V

Henry W. Glasgow has resigned as superintendent of the Nagle Steel Company at Seyfert, Pa.

V V

C. H. Rose has been appointed to the newly created position of comptroller of the Brier Hill Steel Company, Youngstown, O.

V V

C. N. Kell has been appointed assistant to the general manager of the forge department of the Duff Manufacturing Company, Pittsburgh.

Some Pointers on By-Product Coke Oven Operations

PROTECTION FOR COAL TAR PRODUCTS AND DYES.

The interest which the owners or operators of by-product coke and gas plants have in the pending bill to regulate the imports of coal tar products and dyes may be realized by a glance at the preliminary report on the mineral resources of the United States in 1918, compiled by the United States Geological Survey.

Among the statistics given are the by-products obtained from coke oven operations in 1918, as follows:

Tar obtained and sold	200.233,002	gals.	$ 6.364.972
Ammonia obtained and sold	423 515.836	lbs.	19,061,777
Gas produced	385,035,154	M. cu.ft.	....
Total gas sold	158 358 479	M. cu.ft.	13.699.515
Benzol products	59,564.376	gals.	25,434,189
Naphthalene	15,890,447	lbs.	650.229
Other products*	....		1 756,345
Total			$66,967,027

The total value of these products does not include the coke produced.

The proposed legislation in question is Bill H. R. 8078, an act to regulate the importation of coal-tar products to promote the establishment of the manufacture thereof in the United States, and, as incident thereto, to amend the Act of September 8, 1916, entitled "An Act to Increase the Revenue and for Other Purposes" which has passed the House of Representatives and now is in the finance committee of the United States Senate, which has been holding hearings in the month of December. In the meantime, a joint resolution, introduced by Senator Penrose, was passed by both houses of Congress, continuing in effect until January 15, 1920, the provisions of the "Trading With the Enemy Act," which prohibits the import of dyes or coal-tar products except by license.

Purposes of the Bill.

The bill under consideration by the senate and which requires favorable action by that body before it can become a law, has as its purposes the protection of a native American coal-tar industry until the time when this industry has reached a stage of development where it can compare successfully with foreign industries of the same character.

Effect of World War.

As is well known, the United States prior to the world war, had depended almost entirely on Germany for its requirements of dyes and many other coal-tar products. Consequently, at the beginning of the war, we found ourselves in the serious situation of having been abruptly cut off from this main source of supply for many vital drugs, dyes and other necessities of modern life.

The Remedy.

The only remedy for this situation was the immediate development of a native industry for producing these necessities. Due to the very intricate, technical nature of the business, which the Germans had developed with great secrecy as to the methods and processes, combined with the protection of a large number of patents in this and other countries this was an undertaking of mammoth proportions. It required not only large expenditures of capital but also the development of an organization of highly trained technical specialists and the use of the German owned patents.

Results Attained.

The Federal government, through the Chemical Foundation, made available to all responsible manufacturers, the use of the German patents for dyes, chemicals and drugs, and remarkable strides have been made in developing a native coal-tar industry. Nevertheless, this industry has not yet reached a point where it can compete with the German manufacturers of these products who have long years of development work and experience back of them. The resumption of general international trade will mean, in the absence of special protective legislation, the flooding of American markets with foreign manufactured coal-tar products and the destruction in its infancy of this vital national industry which was called into being by wartime necessity. Bill H. R. 8078 is designed to furnish the machinery for the protection essential to the continued existence of the American coal-tar industry in this country.

Public Interest.

The public interest demands that, as far as practicable, this country shall be self-contained industrially and that we must be self-contained in the matter of essential drugs and in those industries which can quickly be turned from the production of important peace materials to vital military necessities. The coaltar dye industry is one of the most important of the latter class. A complete dye works can be almost instantly turned into a plant producing explosives, poison gases and chemicals necessary for modern military warfare, using virtually the same equipment, the same raw materials and the same force of technical experts. Many well known drugs are coal-tar products made from basic materials similar to those used in dye making.

Present Status of American Industry.

The growth of the American dye industry during the four years of the war has proven conclusively that this country has within itself every facility necessary for developing, in a few years, an industry that will fulfill all of our requirements.

A very large amount of money has been invested and the necessary highly technical organizations are being perfected to carry on this industry. Before the war, over 950 colors were being imported into the United States. Today approximately one-third of these are being made in this country and many others are in course of production and the industry also is producing many of the well known drugs and other necessary products.

Menace of German Competition.

During four years of war, the great German dye factories have been running full blast. Their product has been chiefly munitions but, in order to utilize by-products to keep their staffs intact and to be ready for peace and "war after the war," they have always made dyestuffs greatly in excess of what Germany could use. Accordingly, they have a formidable surplus which they must market abroad or waste. If Congress does not act before peace is finally declared, a flood of dye materials will be released and under its irresistible impact, our die industry will be engulfed in certain ruin.

In view of the protection which other nations are giving to their native coal-tar industries, the German dye trust, which has been founded for world trade, must capture the American market at all costs. Otherwise, it will find itself tremendously over-inflated with no outlet for its enormous production.

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*Includes sodium, ferrocyanide, pyridin oil, nut coke, drip oil, spent oxide, carbon, residue, coal tar paint, and wash oil.

WITH THE EQUIPMENT MANUFACTURERS

SOLDERLESS CONNECTORS COMBINE EFFICIENCY WITH ECONOMY.

Affording a 100 per cent efficient splice of wire or cable, that will stand maximum overload without injury, the Westinghouse-Frankel solderless connectors represent a new method of splicing which combines reliable service with marked economy. They are simple in design, strong, and are easily installed. They are made in various styles and sizes for adaption to all types of splices with all varieties of wire.

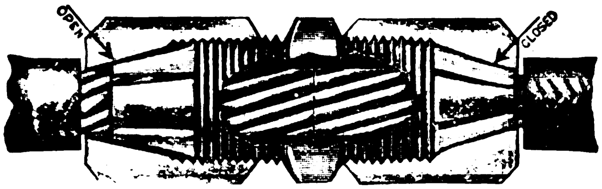

Fig. 1—Longitudinal section of two-way connector.

In making use of a two-way connector, the insulation is removed from the ends of the cable or wire, to be spliced for a distance equal to half the length of the connector. The bared ends are then inserted into the connector so that they meet at the center, after which the compression nuts are tightened. These nuts are so constructed that they force inward a set of jaws at each end of the connector, causing them to grip their respective conductors firmly, forming a perfect joint.

Splices with the other styles are made in the same manner as with the two-way type.

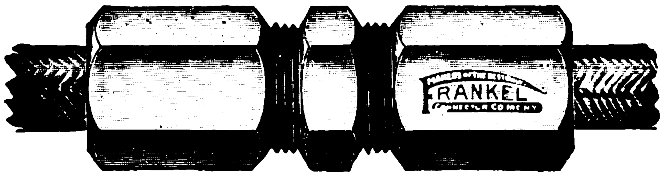

Fig. 2—Two-way connector.

These devices are furnished with a plain finish unless otherwise specified. They can be had, however, with finishes of the following colors, at a small advance in price: Nickel, copper, bronze, copper oxidized, and satin bronze.

It is noteworthy that the connectors have been approved by the National Board of Fire Underwriters. In a burnout test with No. 1 stranded cable in which both a soldered lug and a solderless connector were included in the circuit, the solder in the lug melted and caused the connection to give way, while the solderless connector withstood the test without serious injury.

MAYER POWER HAMMERS.

The Kaukauna Machine Works, Kaukauna, Wis., has redesigned its line of Mayer power hammers. The hammers are built with heavy gray cast iron frames, made in one part for the smaller hammers and in two parts for the two larger sizes. The rams are steel castings and operate in V-guides. The guides are cast integral with the frames with a cored opening between them which makes it possible to spring them apart before machining, thus providing for the takeup for wear and doing away with all gibs. A separate adjustment at the tops and bottoms of the guides makes possible adjustment for excessive wear at the lower ends of the guides where the wear is naturally heavier. The ram connections are designed to provide a cushion at the upper extremity of the stroke which in turn adds to the impetus of the next downward stroke and blow. An alloy steel is used for the togglebolts. Provision is made for adjusting the spring tension. The removable bearing bushings used are medium hard gray iron castings. The dies are made from crucible steel and are regularly furnished with either standard flat forging faces or with rounded faces for plow work.

The hammers are built in five sizes having a respective capacity of 25. 50. 100. 250 and 500 lbs. They will forge round stock from 2 inches to 8 inches and square stock from 1¼ inches to 7 inches. Flat stock from 2½ inches to 8 inches wide can be handled edgewise. Power required, 1 to 7½ hp. Weight without motor, 750, 1,500, 3,000, 5,800 and 10,000 pounds.

URGE SUPPORT OF AMERICAN WELDING SOCIETY

The recently formed American Welding Society has filled a long-felt want in providing a representative association for properly organizing the welding industry and also for standardizing welding practices and methods of training welders.

A membership in the American Welding Society will aid those interested in welding to increase their knowledge and improve their application of the art. The success of the society will mean much to the welding industry and will affect every man connected with that industry. All individuals and organizations interested in welding are urged to join and get interested friends to join. Write the Secretary, American Welding Society, 33 West Thirty-ninth street, New York, for a prospectus and a membership card.

INLAND STEEL COMPANY'S PLANT INSTALLS POWDERED COAL EQUIPMENT.

Reconstruction with a view to increasing production and efficiency to meet the constant heavy demand for sheets has prompted the Inland Steel Company to proceed at once with the installation of a complete powdered coal system for firing 40 furnaces in their plant at Indiana Harbor.

Greater output per ton of fuel used and reduced labor cost are to offset the present labor shortage and high cost of fuel.

For the initial installation, powdered coal will be applied to 16 sheet furnaces, 16 pair furnaces, three continuous plate mill furnaces, two continuous bar mill furnaces and three slab heating furnaces.

The contract which has been awarded the Quigley Furnace Specialties Company, 26 Cortlandt street, New York, calls for the engineering work and installation of a complete milling plant of 20 tons hourly capacity with provision for extensions, compressed air distribution system for transporting pulverized fuel to furnace bins through small diameter standard wrought pipes, and the necessary fuel feed controllers, air supply system and burners.

Arrangements are also being made for an extension to their boiler plant and other departments.

A contract recently signed between the Fairbanks company and the Lincoln Electric Company of Cleveland, O., gives this company the exclusive distribution of Lincoln electric motors for industrial applications.

Trade Notes

An announcement is made by the Westinghouse Electric & Manufacturing Co., that R. A. Neal has been appointed as manager of their switch section, succeeding F. A. McDowell, now manager of the newly created cost and development section. Mr. Neal came to the Westinghouse Company shortly after his graduation from New Hampshire State College in 1910, and has served in the various capacities of order man, inquiry man and assistant manager of the switchboard section.

R. A. NEAL.

Lewis H. MacLaughlin, formerly assistant to the vice president and chairman of the sales committee of E. F. Houghton & Co., of Philadelphia, has rejoined the Fletcher Works staff and will apply himself to research and sales promotion work in the centrifugal division. Mr. MacLaughlin was formerly advertising manager of Schaum & Uhlinger, Inc., and Atlas Ball Company and general sales manager of the Tahara Company of America. The change took effect January 19.

A. S. Winter, formerly connected as advertising and sales manager of the William Powell Company, has joined the sales force of the Fairbanks Company, Pittsburgh, Pa., and will represent them in Southern Ohio.

J. B. Johnston, formerly manager of the ordnance department, Crucible Steel Company of America, Harrison, N. J., has been appointed general manager of the Standard Scale & Supply Co., Pittsburgh, Pa. The Standard Scale & Supply Co. specializes in the building of railroad track scales and heavy duty industrial scales.

In addition to the district sales offices recently announced by the Booth Electric Furnace Company, the company announces that they have opened a Detroit office in charge of M. A. Beltaire, Jr., at 805 Hammond Building, as well as an office at Birmingham, Ala., in charge of Gassman and Cunningham, Brown and Marx Building. The Booth Electric Furnace Company report the sale of 20 of their Booth rotating electric brass furnaces, which includes a number of repeat orders. These orders cover all four sizes from 250 to 2,000 pounds. Announcement is also made of the sale of a two-ton Booth two-phase steel melting furnace to the Cincinnati Steel Castings Company, Cincinnati, O.

O. A. Olstad, formerly connected with the New York office of the Blaw Knox Company, has been made manager of the New England territory, with offices in the Little Building, Boston, Mass., succeeding A. W. Ransome, who has been appointed manager of the Pacific Coast territory, with offices in the Monadnock Building at San Francisco.

Col. G. A. Burrell, formerly chief of the Chemical Warfare Service, United States Army, has organized the Burrell Technical Supply Company, with offices in the Chamber of Commerce Building, Pittsburgh, Pa. Col. Burrell is president of the company, the other officers being J. T. Ryan, vice president; G. H. Deike, treasurer, and G. C. Nelms, secretary. The personnel also includes G. H. Burrell, E. H. Kellogg and R. P. Mase, formerly chemical warfare service men.

After several years experimenting with alloys and special steels for heat-treating, the Quigley Furnace Specialties Company, 26 Cortlandt street, New York, is putting on the market a complete line of carbonizing pots and annealing boxes for heat-treating. These products are made of a special analysis steel known as Q-Steel, designed for maximum resistance to oxidation, coupled with minimum cost per heat-hour of service, being the result of several years investigation and practical experience in heat-treatment. In addition to the low priced steel boxes and special castings they will also market two high grade alloys for similar work where the operating conditions make more economical this class of material. The Quigley organization is backed by 20 years experience in the design and operation of furnaces and in the heat-treatment of metals, and is in a position to render special service to the user of these products and recommend the most economical material for specific purposes. The department of heat-treatment will be under the management of H. H. Harris, who has a wide acquaintance in the heat-treating field and comes to the Quigley company well equipped with information on heat-treating problems, having had several years practical experience in the application of materials for this purpose.

Trade Publications

The Brown Instrument Company, Philadelphia, Pa., has recently issued a new catalog. This catalog contains 88 pages and cover, 8x10½ inches, elaborately illustrated with 159 copper plate halftones and diagrams. The catalog also gives valuable information regarding resistance thermometers, recording thermometers, pressure gauges, draft gauges, tachometers, time and operation recorders and other instruments of Brown line.

A. W. Ransome, formerly manager of the New England territory, for the Blaw-Knox Company, with offices at Boston, Mass., has been transfered to San Francisco, in the capacity of manager of the Pacific Coast territory with offices in the Monadnock Building, San Francisco.

The Leeds & Northrup Co., of Philadelphia, has just issued their catalog No. 86-B containing a complete description of the construction, manner of using, applications and calibration of their optical pyrometer. This 28-page catalog also contains some interesting and instructive illustrations showing how this pyrometer is used for different classes of work. Anyone interested in obtaining a copy of this catalog should address the above company.

Experiment Stations of the Bureau of Mines.

In connection with the work of the Bureau of Mines, Department of the Interior, the bureau is now conducting 11 mining experiment stations, located in the various mining centers of the country, and bending their energies toward the special mining problems that are local to their part of the country. So great has been the demand for knowledge concerning the character of the work undertaken at these various mining stations and its general relation to the mining industry, the bureau has issued a bulletin describing the work of the stations.

Dr. Van H. Manning, director of the bureau, sketches the work of the different stations as follows:

"The station at Columbus, O., situated at a clay-working center is employed mostly on ceramic problems. In this country there are about 4,000 firms manufacturing clay products, including brick, tile, sewer pipe, conduits, hollow blocks, architectural terra cotta, porcelain, earthenware, china, and art pottery. The amount invested in these industries is approximately $375,000,000 and the value of the products exceeds $208,000,000 annually.

"The station at Bartlesville, Okla., is investigating problems that arise in the proper utilization of oil and gas resources, such as elimination of waste of oil and natural gas, improvements in drilling and casing wells, prevention of water troubles at wells, and of waste in storing and refining petroleum, and the recovery of gasoline from natural gas.

"What the Bureau of Mines has done for the great coal mining industry, chiefly through investigations at the experiment station at Pittsburgh, Pa., has been published in numerous reports issued by the bureau. One of the more important accomplishments has been the development and introduction of permissible explosives for use in gaseous mines."

The Blast Furnace and Steel Plant

Pittsburgh, February, 1920.

MORGAN
OF WORCESTER

Continuous rolling with its attending low operating cost and high production has always been fully appreciated by the steel masters of the world

Conditions during the last year have intensified as never before the demand for rolling mills producing a maximum of output per man and as a consequence there are 17 new Morgan Continuous Rolling Mills under construction.

6 for the United States
4 for Great Britain
7 for France

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